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DESIGN FOR THE TOWER BRIDGE.

THE following is a description of the design proposed by Mr. R. M. Ordish and Mr. Ewing Matheson, as illustrated herewith: The bridge is in one span of 850 ft., with four main ribs or arches of wrought iron or steel. The thrust of the arches would be taken on masonry abutments built on concrete foundations on the London clay, which is well suited to sustain such a load. The roadway is suspended from the arched ribs by vertical members strongly braced together, and in the center a portion of the roadway is movable and made to hinge upward as a bascule bridge, leaving an opening 120 ft. wide and 120 ft. high for vessels to pass through. The arched form of the bridge, its width, and its great weight, not only afford sufficient stiffness and stability against wind pressure and the strains caused by the traffic, but in regard also to the possible collision of vessels passing through the bridge, the structure would have ample strength. Even at high water the bridge would be clear above the hulls of the largest steamers navigating this part of the river. The one clear opening of 120 ft. in an unobstructed tideway, as here proposed, would afford as great facility for navigation as the wider opening proposed in the corporation design, where the channel is obstructed by large piers in the center of the river. If, however, it were deemed important to provide a wider opening than here proposed, the design would admit of an opening of 150 ft., or even 200 ft. This is, however, deemed unnecessary and inexpedient. In regard to the future addition of a railway, which is contemplated, if the time should arrive when the movable part of the bridge was no longer opened, it is proposed to carry the four lines of rails above the road traffic, as shown in the cross section, namely, two lines above each roadway, this higher level being as necessary for the railways as the low level is for the street traffic. The bridge would be erected as follows, as shown in the engraving: On either shore of the river suitable staging would be erected to carry a half span of one pair of ribs, and during the building of these ribs the road traffic below could be arranged to pass through openings in the staging. By means of a sufficient counterweight at the shore end balancing the overhanging weight of the rib, the staging could be removed, and the half arch propelled forward over the river on a suitable cradle resting on the approaches till it met the corresponding half arch in the middle of the stream, and the two halves would then be united. The second pair of ribs could then be erected in the same way, and then braced to the first pair. From the arch ribs the platform of the bridge would then be suspended and braced, leaving open

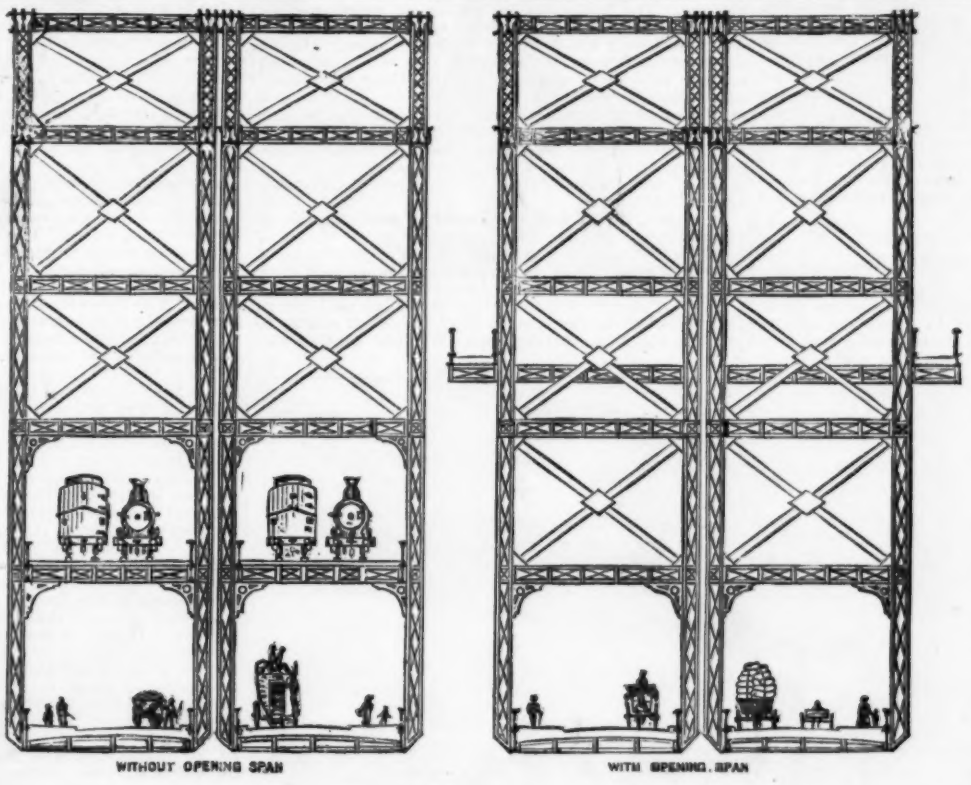
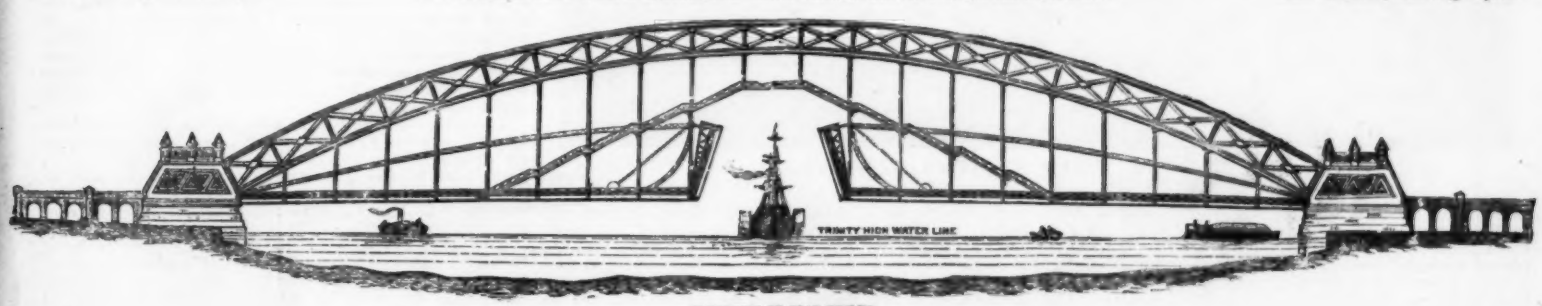
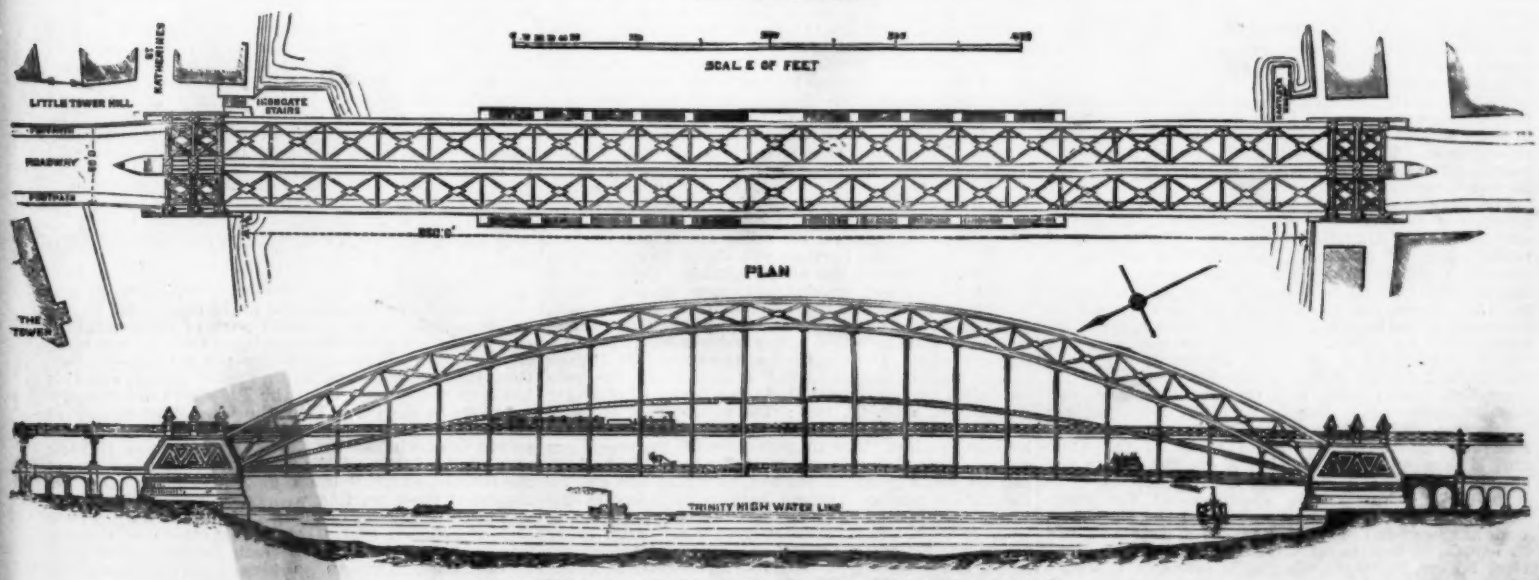


DIAGRAM SHOWING STAGING AND LAUNCHING ARRANGEMENT.



ELEVATION OF ROAD BRIDGE



ELEVATION OF ROAD BRIDGE WITH RAILWAY ADDED.

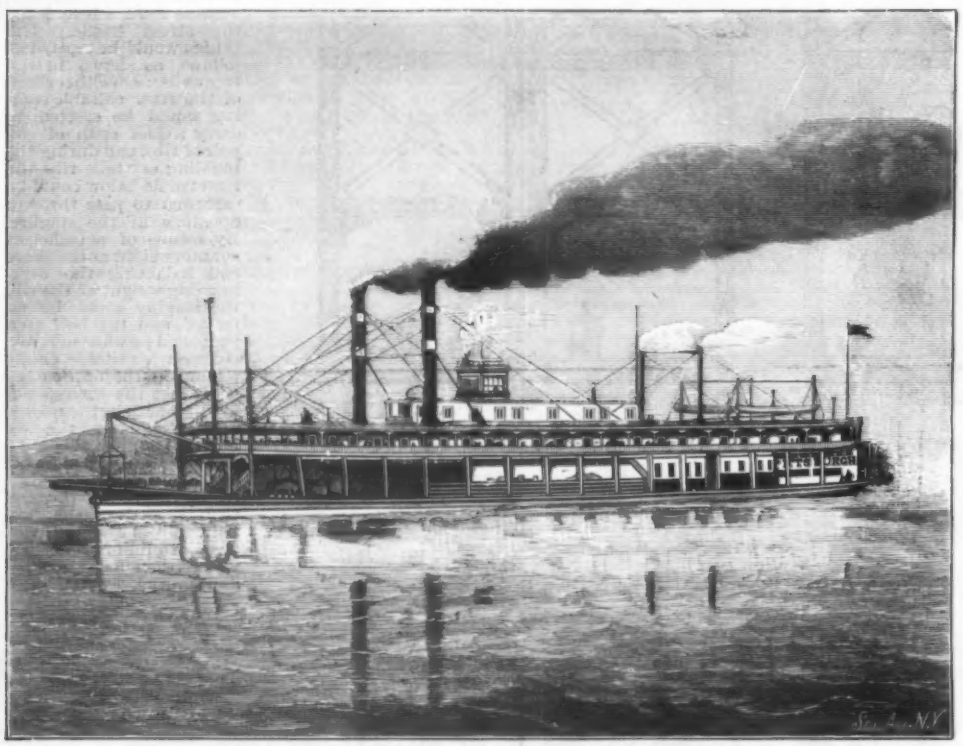
PROPOSED LOW LEVEL BRIDGE OVER THE THAMES, LONDON.

in the center of the bridge a gap 120 ft. wide for the movable part. This gap would be filled by a bridge in two halves, each hinged, and with a counterpoise so arranged as to afford at all positions, while moving in the segment of the circle, the altering weight necessary for a balance. Only a moderate force would, therefore, be required, and this could be conveniently obtained from the mains of the Hydraulic Power Company now laid along the banks of the river, and constantly charged with water at a pressure of 700 lb. per inch, or by other motive power. The counterbalance weights and mechanism would be placed in the spaces available inside the arched ribs, and would present no obstruction to the road traffic.

During the interruption to the road traffic while the bridge is open for masted vessels, foot passengers could cross by stairs attached to the outside of the main ribs, as shown in the engravings. If the time arrives for the closing of the opening span, it would be easy to alter the moving part of the bridge to make it like the fixed part. If then or thereafter a railway were to be added, an upper floor could be placed, as shown in the engravings, some of the bracing being removed to make room for it. The railway approaches to the bridge on either side of the river would be on a viaduct, which would be made in convenient spans, so as not to impede the road traffic below. The estimated cost of the bridge in the first instance—that is to say, as a road bridge, with mechanical opening and without the railway—is £820,000. This sum does not include the cost of land or compensation. The cost of altering the structure to a closed bridge and adding four lines of railway would be about £20,000.—*The Engineer.*

THE STEAMER PITTSBURG.

THE light draught stern-wheel steamer, now the predominant type used on the Ohio and Mississippi rivers and their tributaries, is peculiar in many respects to the West. In former years the stern-wheeler was considered, on account of slowness, unfit for the river traffic, but the rapid strides in its perfection which have been made on the Ohio in recent years have placed it almost beside its rival side-wheeler in point of speed. The exterior appearance of these boats is strikingly graceful, the long unbroken lines from stem to stern, together with their very slight sheer, giving them great beauty. The boilers are located on the main deck, about one-third the boat's length from the bow. The wheel is never housed, but remains open. The engine room aft occupies but a small space, and the remainder of the deck room is devoted to freight. The cabin is on the upper deck, and on all of the boats in the passenger carrying trades is complete and elegant in every respect. The officers' cabin occupies the hurricane deck. The saloon extends nearly the entire length of the boat, and on many steamers is palatial in its appointments.



THE LIGHT DRAUGHT STEAMER PITTSBURG.

The desideratum, of course, in all steam vessels is economy of power. In Western steamboats the very extreme of light draught is necessary. The hulls must be flat bottomed, and built as lightly as practicable with the requisite strength for large cargo carrying. The machinery must be as light as can be made, and for this reason the simple, high pressure, horizontal, lever engine has been found to meet the requirements better than any other. The long return-flue boilers, which, on all boats of late build, are made of steel of the highest tensile strength, are better adapted for several reasons to these boats, on account of mud, etc. Besides, their shape distributes their weight over a larger area. There is no doubt that, for the weight of machinery used, the improved boats of the Ohio and Mississippi rivers develop a greater power and speed than any other class of steam vessels.

Among the remarkable specimens of the stern-wheeler on the Ohio may be mentioned the Pittsburg, built at Cincinnati in 1879. Her hull measures 252 feet in length, 39 feet beam, 6 feet hold. She has three steel boilers, 70,000 pounds tensile strength, 47 inches diameter, 28 feet long, 6 flues. Engines, 21 inches diameter, 7 feet stroke, working a wheel 21 feet diameter, 28 feet face. With fuel on board and steam up this boat draws only 24 inches water, and will carry 1,000 tons. She is one of the fastest steamers on the river. The large Golden City, plying between Cincinnati and New Orleans, is 276 feet long, 40 feet beam, 7 feet hold, and carries 1,600 tons. The steamer Buckeye State, of the Upper Ohio, is 240 feet long, and can carry a large cargo on 4 feet water.

These boats are complete with all the modern appliances of steam stages, capstans, windlasses, headlights, etc. The electric light has been applied with great success to several steamers during this year.

OCEAN LIGHTSHIPS WITH CAPTIVE BALLOONS.

To the Editor of the Scientific American:

On pages 133, 160, and 245 of present volume of SCIENTIFIC AMERICAN appear very timely articles concerning lightships for the path of ocean steamers to Europe. The lightships, life saving or signal stations are proposed to be electrically connected with each other and with the Atlantic telegraph cable. Of the many eminent uses of the same, one of the principal ones is probably the ability through them to at once make known accidents to steamers or other ocean crafts, to have assistance sent from the continents, or from other crafts seen to be within signal distances of the lookout of the lightship. Your correspondents, however, omit the most important point in demonstrating the necessity of them and their usefulness—captive balloons.

In March, 1883, I had the honor to send you one of my circulars, "Safety at Sea during Fogs by Means of Captive Balloons," and have it noticed in your issue of March 17, 1883. Your correspondents must not have seen said article, or they would undoubtedly also have associated captive balloons with lightships, as I did in 1883 with lighthouses and all kinds of ocean crafts, to prevent collisions during fogs. Without captive balloons, the use of lightships or ocean signal stations will indeed be quite limited—the rotundity of the earth preventing sight of any objects, from the usual heights of ocean steamers' decks, unless at least as high, and within 15-20 miles. To see objects for even so short a distance requires an elevation above sea level of respectively 28-50 feet from both steamer and lightship. A wrecked crew in a small boat 2-3 feet high would have to come within 10-12 miles of the lightship, to be seen from an elevation of 50 feet. Should the lookout on the lightship be situated 100 feet high, the horizontal line would be but 14¼ miles distant, and small boats little beyond that distance out of sight. Disabled ocean crafts cannot always bring themselves within that distance of ordinary lightships, and must therefore remain without assistance from them.

Quite different would be the case if the lightships are provided with captive balloons. From a balloon a mile high, a view of the sea 100 miles in all directions is possible. From a balloon 20,000 feet high, 200 miles. Two lightships with balloons, 400 miles apart, can see one another above the horizon and signal to each other, the transparency of the air permitting. Between the Grand Banks and Ireland, a distance of 2,000 miles, 4 lightship balloons in the ocean and one on each shore, all 400 miles apart and up 20,000 feet, could signal across the ocean, send messages across independent of the telegraph cable. The distances of the horizontal lines as herein stated are calculated according to the rule published by astronomer R. A. Proctor in SCIENTIFIC AMERICAN, Sept. 20, 1884: The square root of twice the elevation in feet above sea level gives distance of horizon in miles. The manufacture of hydrogen gas on board of a ship presents no difficulty. The balloon can be made gastight enough, to retain the gas for days, if not weeks. A small balloon 14-15 feet in diameter is supposed large enough for one person, using hydrogen gas. Then, at least immediately after every storm, the balloon ought to be sent up as high as convenient, 15,000-20,000 feet, to enable an observer to a view of respectively 173 to 200 miles in all directions, looking for disabled ocean crafts, showing signals of distress. The particulars of such accidents could be signaled to the lightship balloons, and by them telegraphed to terminal points on shore, to have arrangements made forthwith, to render the assistance required.

In addition to what has been said by your correspondents in regard to anchoring the lightships in depth of 2,000 fathoms, I would say that it must be apparent to every one that even the best steel wire chains or wire rope for such a depth are out of the question, unless buoyed up as explained below, on account of their weight; the upper portion being only about able to sustain the weight of the cable, leaving little remaining strength to hold the ship. A steel wire rope manufacturer, in his circular, places the breaking strain of a cast steel wire rope 2 inches in diameter at 110 tons of 2,000 lb. each. The proper working load is stated to be 23 tons. The weight of the same wire rope is said to be 7 lb. per foot = 42 lb. per fathom = 42 tons for a length of 2,000 fathoms. The weight of the rope in sea water would be about 5 tons less, or 37 tons, still 60 per cent. more than the proper working load is rated in the circular mentioned. The principal portion of the Atlantic cable is laid in a depth of 2,000 fathoms. The anchor cable must necessarily be at least of that length, and cannot, as shown, be of heavy solid steel, but should be of sufficiently strong material, as near the gravity of water as possible; with such a cable, anchoring in even ten times 2,000 fathoms depth, ought to be possible. A sectional hollow column has been proposed, according to your paper, years ago. I would suggest wrought iron tubes of about one fathom length, closed at both ends with screwed-in plugs with eyebolt extensions. Such separate tubes can be linked together, and if the tubes are of sufficient cavity, a chain of them can be of the gravity of water. The weight of such cables 2,000 fathoms or longer would not curtail its strength. The whole tensile strength of it can be appropriated by the lightship, and none lost by bearing up its own weight. The tubes should be galvanized, if thereby the iron and the cavity of the tubes can be better preserved from the immense pressure of 5,348 lb. per square inch at a depth of 2,000 fathoms. The tubes need not be as bulky to float as it may seem. With a cavity 7-8 times larger than that of the solid iron composing the chain, the gravity of water is attained. To such an anchor cable the ship's electrical cable, to be connected with the Atlantic telegraph cable, is fastened once in every 3-5 fathoms its entire length. Although much heavier than water, it is floated by the anchor cable and not strained in the least, therefore durable. When first the lightship's electric cable is joined to the ocean cable, the latter is raised to the surface, the connection completed, dropped again, with sufficient slack ship's electric cable, below the ship's anchor, to insure a safe distance between the ship's anchor and the ocean cable, in their places on the floor of the ocean.

When it is found that hemp rope cables can be well preserved from the action of sea water by newly discovered chemical compounds, and its specific gravity not too great to be reduced by a lighter cork and gutta-percha or caoutchoue composition covering, to the same gravity as water, then a hemp rope cable 4-6 inches in diameter will be strong enough for a lightship's anchor cable. The ship's electrical cable can be fastened, as to the hollow wrought iron tube cable, to the outside of it, or it may be the center strand in it. Such light anchor cables will require but small buoys. The rising and falling of buoys during rough weather exert dangerous strain to all kinds of anchor cables. I would suggest a yielding, spring-like attachment between the buoy and the cable, or near the upper end of it. Such an attachment to insure almost perfect quiet to the anchor cable is easily contrived, if not perhaps already invented and in use. The lightship fastened to the buoy can, whenever necessary, disengage itself. It may be expedient occasionally to do so, when, for instance, a tornado, waterspout, or an iceberg should require its place for a passage way. The buoy would of course obligingly duck below the surface for the time of the berg's passage, but the lightship will have to clear the track, unless the crew is prepared to make smithereens out of the monster from Greenland by firing dynamite shells into its interior.

Tornadoes can, as I have set forth in a contribution to your paper of February 2, 1884, be effectually blown up or annihilated by explosions of gunpowder. A torpedo boat loaded with gunpowder could be sent to meet an approaching tornado or waterspout at sea, exploded at the right moment by electricity from aboard the lightship.

The ordinary steel wire chains or cables may perhaps be used for deep sea anchor cables, if a sufficient number of hollow floats of boiler iron are attached at suitable distances every 3-5 fathoms, the entire length of the cable, so as to make it floating or self-supporting, as the others above described.

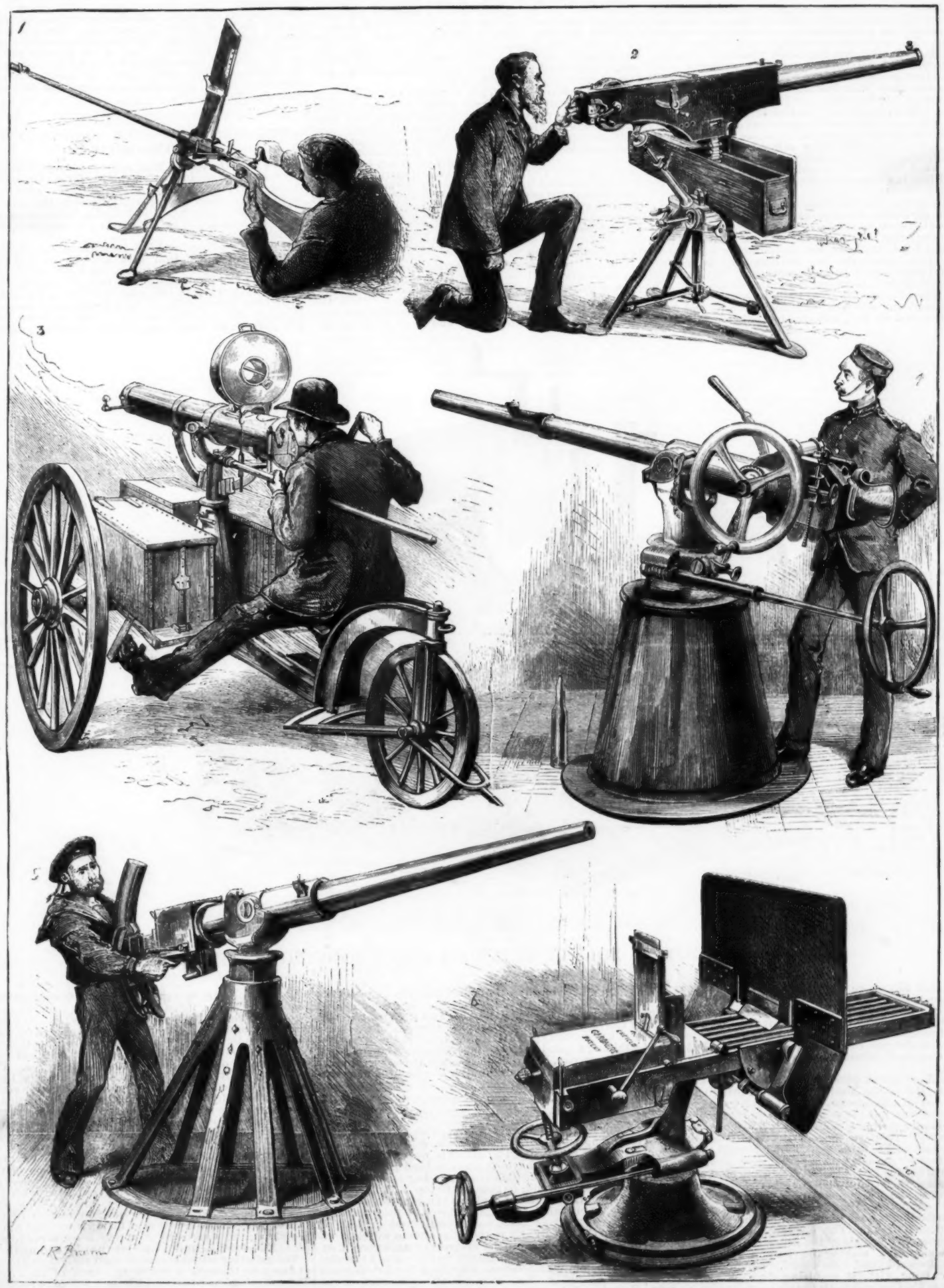
The practicability of safely anchoring lightships in depths of 2,000 fathoms or more must now be admitted to be demonstrated; equally so the necessity and usefulness of such electrically connected signal stations or lightships with captive balloons. An ever increasing ocean traffic will peremptorily demand them. The chief officers of our signal service and life saving bureaus inducing the government to establish them will be rightly considered benefiters of mankind.

JOHN F. SCHULTZ.

New York City, May 25, 1885.

MACHINE GUNS AT THE INVENTIONS EXHIBITION.

EVER since the Franco-Prussian War, in 1869-70, machine guns have been adopted in the armies and navies of all nations as an essential part of their military equipment. The terrible rapidity of their fire—in some cases reaching 1,200 cartridges per minute—renders them invaluable in repelling a sudden attack, and this has been amply proved by the Russians at Plevna, by ourselves in Egypt, and by the Canadians as late as Saturday last, when General Middleton's force was preserved from disaster by the adroit use of one Gatling gun. Indeed, one of the most interesting sections of the Inventions Exhibition is undoubtedly the extensive display of these terrible weapons. The earliest form was the mitrailleuse, in which a number of barrels were arranged round a central axis. Next came the "Gatling gun"—an improved form of which has been illustrated by our artist. This gun has usually ten barrels and ten corresponding locks, and in working the gun the barrels and locks revolve together—though irrespective of this motion the locks have a forward and backward



1. Single-Barrel Nordenfeldt Magazine Gun.—2. The Maxim Gun.—3. 10-Barrel Gatling Gun with Accles' Positive Feed.—4. Rapid Firing Nordenfeldt Shell Gun.—5. The Hotchkiss Gun.—6. The Gardner Gun.

MACHINE-GUNS AT THE INTERNATIONAL INVENTIONS EXHIBITION, SOUTH KENSINGTON.

motion of their own. The forward motion places the cartridges in the chambers of the barrels, and closes the breech at the time of each discharge, while the backward motion extracts the empty cartridge cases after firing. The gun is fired by turning a handle, and when the gun is in action there are always five cartridges going through the process of loading and five cartridge cases in different stages of being extracted, and these several operations are continuous while the gun is being worked. Thus as long as the gun is fed with cartridges the several operations of loading, firing, and extracting are carried on automatically, uniformly, and continuously. The reservoir of cartridges may be seen on the breech, and with the improved "positive" "feeder" there shown, 1,200 shots can be fired per minute.

Another gun shown is the "Maxim," and for this the inventors claim that it is the first and only gun which is automatic in its action.

In ordinary machine guns the functions of loading and firing are performed by operating a crank or lever. In the Maxim gun, however, these are achieved by the gun itself, the recoil being utilized for this purpose. The first cartridge is placed in the barrel by hand, and when this is fired by pulling the trigger, the recoil resulting from the first discharge fires the next cartridge.

The second cartridge fires the third, and so on.

The cartridges are made into a chain or belt by being placed between two strips of tape.

Before firing, one end of the tape of cartridges is introduced into the gun, and as the firing goes on, the tape is drawn into the gun, the cartridges drawn from it, and the empty tape and empty cartridge shells discharged through apertures in the side of the arm. The gun may be arranged so as to fire single shots, pulling the trigger for each shot, or it may be adjusted to fire itself slowly: in fact, the speed of discharge may be regulated anywhere between one shot and 600 per minute.

As the gun is self-contained, and has no crank or lever to interfere with its action, it may be turned in any direction while being fired at any rate of speed.

The Maxim gun can be made of any size, but those shown at the Exhibition are the smallest type manufactured.

The Nordenfeldt Quick-firing Shell Gun.—The illustration shows the Nordenfeldt quick-firing shell gun, mounted on a naval carriage. The gun exhibited is of a smaller size, but of the same type and principle as the six-pounder shell gun of 2·24 inch caliber now used in the navy. This gun is only of 1·65 inch caliber, and fires shots of 2·5 lb. weight with a muzzle velocity of 2,000 feet per second, with a penetrative power at 300 yards of 3¼ inch steel plate. The shots used are either solid steel, shells, sharpnels, or case shots, held in the neck of a solid drawn metal case containing the charge of 1·2 pounds of gunpowder.

The feeding is done by hand from the rear through the opened breech. The opening and closing of the mechanism, the cocking, the firing, and the extraction is all done by moving the handle a quarter of a circle forward and backward, which is conveniently done without requiring strength. At recent firing at Portsmouth with the six pounder gun, twenty shots have been fired with ease in half a minute, and the same rapidity is obtained by this gun.

The carriage is constructed to enable the gun to be "laid" with promptitude and exactness by simply turning two hand wheels; at the same time giving perfect stability to the gun.

The Single-barreled Magazine Gun.—This illustration shows what we should call a magazine machine rifle. It is a gun weighing only 13 lb., or little more than a Martini-Henry rifle, mounted on a tripod support for firing by the man lying on the ground. The gun is meant to be used where circumstances do not admit of the transport of a heavier weapon, but where, at the same time, something more effective than a rifle is wanted. The gun rests with a shoulder-piece against the left shoulder of the man, and, moving freely round its pivot and trunnion, is easily "laid," while the right hand works the gun. It fires the usual rifle ammunition. The rapidity of firing is equal to the movement of the hand, and 100 shots per minute can easily be fired, allowing for time to change hoppers. The gun is fed from the magazine above. The total parts of the mechanism are only six, viz., the plunger, an action slide, a firing spring, a firing pin, a cocking spring, and an extractor, besides the hand lever.

The Hotchkiss Gun.—This is called a non-recoil gun, for being mounted on elastic pivots for naval service, it is without perceptible recoil, and can be fired from the shoulder. It fires a single cartridge containing powder and projectile, and the breech mechanism automatically extracts the empty cases. It is, however, fed by hand and cannot therefore, strictly speaking, be called a machine gun. The gun shown in our illustration can be trained and fired by one man; and, being only bolted to the deck, it can easily be removed for service on land. It carries a six-pound shell. 360 Hotchkiss guns, including six and three pounders, are in the English naval and land forces; France has 1,950, Germany 600, Russia 215, Austria 67, Italy 102, Holland 126, United States 86, and other governments 145.

In the "Gardner gun" the cartridges on being placed in the reservoir fall by gravity to their place at the rear end of the barrels. The turning of the handle actuates the simple mechanism, and the "plungers" push the cartridges into the barrels, while the continuous rotation of the crank extracts the empty shell of the cartridge. In the one and two barrel gun the empty shells are expelled through orifices at the side of the gun, and in the five barrel they are withdrawn from the rear end of the barrels. The speed in the rotation of the hand crank necessarily gives the rapidity of fire, the five-barrel attaining a speed of 1,200 shots a minute. The cartridges fall by gravity, but the speed is always accelerated by the firing of the gun and by the insertion of new cartridges.—*London Graphic.*

COMPRESSED AIR LOCOMOTIVES.

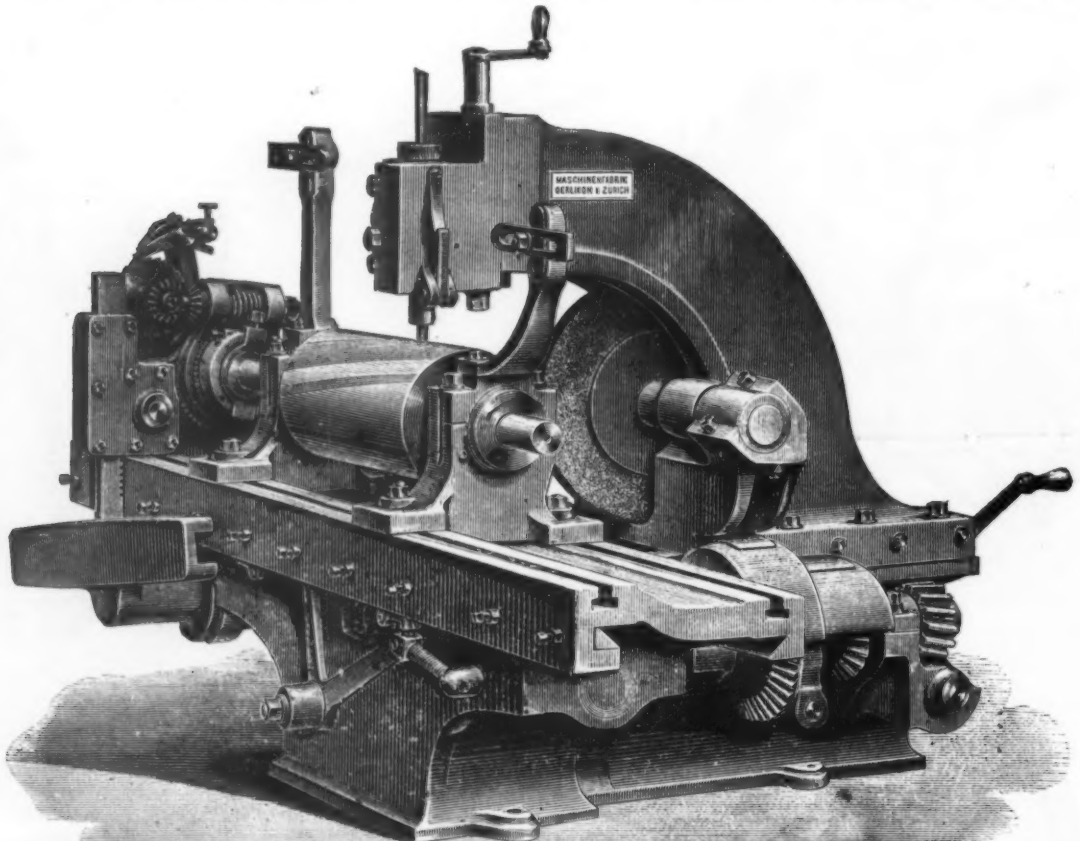
COL. BEAUMONT says: If you wish to store a sufficient amount of air, you must use high pressure or a very large reservoir. The latter is nearly an impossibility, and so you have to employ high pressure. To put the matter more plainly—supposing a man is working on the treadmill; he goes to the top of the machine, and then the weight of his body is useful as a power. I made up my mind that the whole of the work should be given to the engine, and none should be lost. I believe that after a short time the system will be running on a large scale on the Liverpool tramways. I am also making small locomotives to take away the dirt from the boring machines. One is for the Bridgewater Trustees, and one for Dover. In these locomotives the diameter of the high prssure cylinder is only 2 in., and the areas of the low and high pressure cylinders are as 12 to 1. There was at one time this difficulty in working with high pressure air—the fittings must be bottle-tight; that is, as tight as a bottle of champagne, or it is no use; this point we have entirely overcome, and as a proof of what I say, I may mention the case of one of the air engines which was running in the Victoria Docks. On one occasion, after trials with this engine, there was some air left in the reservoir, and some time afterward the engine was put on the tramway, and it went away as well as before. This shows conclusively that the air can be stored and preserved for use. As another proof of the way these things can be made, one of the tram engines working on the Leytonstone branch, owing to a mistake of the driver, had too much speed—going, I believe, twelve miles an hour. She jumped the rails and over anything near, finally sinking down into the asphalt. They obtained jacks and levers, and got the engine on the track. All this time there was a pressure of 250 lb. of air in the reservoirs. This also shows that engines of this kind will stand the rough work of the collieries. One cubic foot of air pressed to 1,000 lb. per inch will take a load of 3 tons for one mile on all the ordinary colliery lines, and by this means, with the consumption of 1 ton of slack, you could get 700 tons of coal brought one mile.

THE OERLIKON ROLLER GRINDING AND GROOVING MACHINE.

Now that the chilled iron roller is so largely used in the flouring of grain, any machinery for giving a fresh surface and cutting fresh grooves in rolls, also those worn by use, must be of special interest to the miller.

The grooving machine illustrated is manufactured by the Werkzeng und Maschinenfabrik, at Oerlikon, near Zurich, Switzerland.

It is claimed that by this grinding and grooving machine rolls of chilled iron with a diameter of 13 to 14 inches and a length of 29 inches can be provided with grooves of any pitch and of any desired number. The machine is worked by one gearing, which is driven best by belting underneath. A long faced drum serves to transmit the grinding motion to the cylinder. For this purpose the large pulley is placed on the grinding



THE OERLIKON ROLLER GRINDING AND GROOVING MACHINE.

wheel, which runs at a great speed. It is evident that the motion of the plane on which the cylinder rests cannot be uniform in both operations of grinding and grooving, and two different pulleys are placed on cross shafts side by side on the hinder bar of the turning lathe. Each of these pulleys receives its own belt, and of these only one is in motion at the same time. The grinding shaft and pulley are driven directly by a worm and wheel on a shaft provided with clutch coupling, and it is by this means that the uniform motion of the roller plane is secured. In grooving, the worm and wheel are removed. The second driving spindle with the larger faced pulley serves partly for a rapid reverse motion, bearing directly, by means of bevel wheels, on the coupling shaft, and partly by means of a counterpart tail and bevel gearing for the slow motion of the cylinder while at work. The double conical wheel on one of the coupling boxes may be connected with the bevel on the grooving spindle by means of a slide. The machine is started by the setting in motion of the plane. For this end, two pegs fitting into a slot under the plane, and worked by a spring lever, serve to displace the clutch coupling and set the plane in motion.

The grinding wheel can be dressed with the diamond at any time through a slot at the back of the drum. The grooving steel tool, which is fixed in a rotating holder, can be connected or disconnected with the two roller bearings by connecting rods. In grinding, these rods are removed. At one end of the plane is an apparatus for distributing the grooves working on a worm and wheel; the number of the grooves can be regulated by a wheel arrangement. On the face, in front, is the ruler, which rotates and is screwed at the back; it is connected by a pinion rack and intermittent wheel with the curved arm, and can be adjusted to any pitch of grooving. This apparatus is also connected with the

plane motion. In grinding, the ruler may either be brought into a straight line with the bed or altogether removed.—*The Miller.*

NEW THERMODYNAMICS.

THE paper lately read by Mr. J. Macfarlane Gray at the Physical Society was on "The Second Law of Thermodynamics." This was the continuation of a paper on "The Thermal and Ergonal Constituents of Heat in Liquid Vapors," read by the same author before this Society in November, 1880, and a paper on "Specific Heats calculated from Entropy," read also before this Society in July, 1880. These papers are all developments of the "Ether Pressure Theory," explained by the author in a paper submitted to the secretaries of the Royal Society on February 18, 1878, and rejected by them as "not suitable for the Society."

In the present paper the author first drew attention to the following corroboration of statements in his former papers.

In the 1878 paper he asserted that it would yet be found that the true velocity of sound in air is 1,087·1 ft. per second, and not 1,090 ft., as it was then supposed to be. Since then the experiments of Sthathmari, at Paris, have made the velocity 1,087·6 ft.

In the paper of date July, 1880, the author states that the molecules of a perfect gas are "entirely devoid of heat," they are "always at absolute zero of temperature." Since then Siemens, of Berlin, has proved by experiment that the gases in high temperature furnaces have no action on the thermopile.

The specific heat of steam at constant pressure given by the author in his former paper, is 20 per cent. less than that given by Regnault, and this disparity was urged as an objection to his theory. In a paper on "Regnault's Determination of the Specific Heats of Steam," published in the Transactions of this Society, the author subsequently demonstrates that Regnault had misread his own experiments; he pointed out the error, and showed that when that is corrected the specific heat then stands at just the 20 per cent. less, according to his former paper.

The author next explains why he had not permitted his former papers to be printed in the Transactions. The original heat of liquids in his theory conflicted with the "Second Law;" this was not observed by the reading committee who had recommended the first paper to be printed, and the author therefore did not value their decision; he waited until he could by some more reliable criticism determine whether his theory of physics on the "Second Law of Thermodynamics" was in error. He saw that that could be decided only by a knowledge of what the specific heat of water is at different temperatures, and he found Regnault's specific heats of water as published crowded with errata. Until this could be settled he regarded his investigations as moulting, and he waited to see whether the thing before him would turn out to be a sparrow or an eagle.

In September, 1880, by the "First Law of Thermodynamics" he arrived at what the specific heat of liquids is, and thereupon he has recently constructed a criterion by which the "Second Law" can be tested by the First Law. That is best explained by reference to the Geometry of Thermodynamics worked out by the author. Therein the line of the state points for water must be the boundary of the thermodynamic field at that side if the "Second Law" be true. Now, in the author's investigations he has found it impossible to locate these points on the boundary, if Regnault's experiments on steam are to be taken as reliable. In the author's present paper he has determined the slope of the primary line of the temperature entropy diagram at intervals of 10 deg. from 0 deg. to 230 deg. C., in terms of θ, the absolute temperature; w, the specific heat of water for θ, a variable; m, the molecular weight, and γ the specific heats ratio for gases, on the assumption that the water state-points do lie on the primary curve as required by the First Law. He has also determined the slope for the same temperatures according to Regnault's formula (H) for steam pressures, and by equating the two results he finds that if the Second Law and the First Law are both valid, then must the specific heat of water decrease as the temperature increases. At 0 deg. C. with $\gamma = 1{\cdot}408$, the specific heat of water would be = 1·064; at 100 deg. C. = 0·9103; at 220 deg. C. = 0·7906. Now these are quite inconsistent with all experiments. On the other hand, when the state-points are allowed to fall within the thermodynamic field, the specific heats are exactly those given in the author's paper in November, 1880. He therefore concludes that the "Second Law" is not true, and that his ether-pressure theory is an analogue of nature.

The author gives the specific heat of liquids as consisting of two parts: the thermal constituent $K = \frac{C}{m}$ where K is constant at all temperatures for the same substances, m is the molecular weight, and C is a constant for, he believes, all substances. He has, as yet, applied it only to water $m = 17{\cdot}96$, and to bisulphide of carbon $m = 75{\cdot}93$. For these widely dissimilar substances the same value holds good exactly, viz.,

$$C = 17{\cdot}01523.$$

The ergonal constituent x is a function of temperature, inner heat of evaporation, and molecular weight, viz.:

$$x = \frac{2\ C\ \theta}{\lambda_1\ m^2},$$

in which C has the same value as given above.

The author also described certain sets of error he had discovered in Regnault's recorded experiments. Before naming these, he would like to record his highest praise to Regnault for the invaluable service he has rendered to science by his experiments. Without them the author could have come to no definite results. Probably the work of pupils and the care of pupils have together led to those minor discrepancies the author has had to deal with in these records. In 220 of the experiments on steam, Regnault gave as the correct temperature the mean of the readings of two thermometers, one placed in the liquid and the other in the vapor. The author states that the temperature of water giving off steam increases from the surface downward, and that the differences which puzzled Regnault are altogether accounted for by assuming that the effective depth of the bulb of the thermometer in the liquid was 3 centimeters. The correction required amounts to 0·325 deg. at 43 deg. C., and to 0·056 deg. at 90 deg., upon Regnault's temperatures, between 43 deg. and 100 deg. only.

Another set of errors seems to be due to seldom, if ever, using Regnault's own coefficient (0·3665) for the expansion of air, but generally, or always, that of Rudberg (0·3646), which Regnault's first series of experiments proved to be in error. This remark applies to all temperatures above 100 deg.

A third set of errors has crept in between 0 deg. and 100 deg. through Regnault having assumed that the calibration of a mercury thermometer must consist of equal divisions if the zero point and the boiling point are correct—a physical impossibility according to the author. This error was on another ground pointed out by Bosscha in Poggendorf's *Annalen* in 1874. Regnault replied in the *Comptes Rendus* without explanation, that the temperatures were correct as given by him, and that as for the letter saying they were wrong, he disdained even to read it. There is no guessing what his opinion would have been had he heard this paper read.

The author then gave what he substitutes for Carnot's function, as modified by Clausius. He would also give great praise to Clausius for his work in thermodynamics. Since his papers in 1880, the author has for his own satisfaction rewritten the whole of Clausius' "Mechanical Theory of Heat" in his own notation, to satisfy himself that he had overlooked nothing. For the theoretical efficiency of heat in the differential reversible cycle engine, according to Clausius, $E = \frac{\delta\ \theta}{\theta}$.

For this Mr. J. Macfarlane Gray substitutes

$$E = \left(1 + \frac{2\ C\ \theta^2}{\lambda\lambda_1\ m^2}\right)\frac{\delta\ \theta}{\theta},$$

in which C is the constant given above, λ the whole heat of evaporation from water θ to steam θ; λ_1 the inner heat of evaporation, that is λ minus the thermal equivalent of the $p\ v$ of the steam, m is the molecular weight.

This paper was announced as third on the list; but it was decided by the Council, just before the meeting opened, and without communicating with Mr. Gray, that Professors Ayrton and Perry's paper on "Incandescent Lamps" should be read out of turn, in precedence to Mr. Gray's paper. Mr. Gray was beginning his paper in the order of announcement, when he was called upon to stop for Professors Ayrton and Perry's paper. Professor Perry rose, and apologized for the absence of Professor Ayrton, who was to read it. Professor Ayrton at last made his appearance, and occupied the meeting until 5 P. M. At Mr. Gray's request, the discussion on Professor Ayrton's paper was then postponed until next meeting, and those of Professor Ayrton's audience who did not care to be bored with this paper of Mr. Gray's left the room, leaving only about twenty, of whom seven were of Mr. Gray's party. Professor Ayrton then took the chair, and by his courteous manner did all he could to make Mr. Gray forget that he had been made of no account in their arrangements. It is on account of the meager attendance awarded the author that we make this notice longer than usual; but perhaps our readers will not consider that we have made it longer than the importance of the subject warrants. We at present, says *Engineering*, express no opinion on Mr. Gray's work as to whether it is reliable or not; if what he says is not all a gigantic blunder, then the science of thermodynamics has to be entirely rewritten, and the lines on his Thetaphi diagram are the very wards of the lock of the casket containing the most valuable secrets of nature, and the thirteen years occupied by him in picking it is, to us, well spent time.

WARMTH, COLDNESS, AND PRESSURE.

AT a recent meeting of the Physiological Society, Berlin, Dr. Goldscheider gave a short sketch of his investigations respecting points of sensation of warmth, coldness, and pressure, in connection with the sense of feeling. The doctrine of the specific energies of the nerves, according to which each nerve fiber was able to conduct only a definite quality of stimulations and sensations, had to encounter, as was known, great difficulties in connection with the sense of smell and the sense of touch, seeing that the number of smells was very manifold, and that, consequently, very many essentially different sensations were taken up and conducted by the primitive fibers of the nerves of smell, while, again, the stimuli acting on the cutaneous nerves were also qualitatively diverse. In the case of the sense of smell the difficulties would perhaps only be resolved when the very various smells were satisfactorily reduced to a few simple fundamental sensations. With respect to the sense of feeling, on the other hand, a sense which comprised the five different qualities of pain, pressure, tickling, warmth, and cold, the latest researches went to show that here in point of fact were different nerve terminal apparatus to be distinguished, each endowed with its own specific energy. In examining the sense of temperature in the skin by means of rounded metallic points, the speaker found that there were a very large number of points which were sensitive to cold, and also a number of other points which were sensitive to warmth. These were unequally distributed over the body, and decreased in number and density toward the periphery. They appeared to stand in a certain contrast to the fineness of the sense of touch, being found more rarely where the sense of touch was very delicate.

On a more minute study of these points it was shown that they were ranged together in the form of chains, and that there were always several chains of cold or of warm points, as the case might be, radiating from one spot of the skin. These radiating centers lay, in the majority of cases, to the number of about 80 per cent., each at the root of a hair, though all hairs did not cover radiating centers of such chains, while, on the other hand, there were radiating points not situated at the roots of hairs.

The chains of cold points, again, never coincided with those of warm points; but these two sets of chains lay adjacent to each other. The cold points were alone capable of generating cold impressions, while all other points of the skin never excited such cold sensations. There were, however, differences among the cold points, inasmuch as some always gave rise to the exclusive feeling of coolness, while others, even under weak stimulations, always produced only an intense feeling of cold. Entirely analogous to this arrangement was the arrangement of the warm points. Some generated the single feeling of lukewarmness, others that of warmth, and others, again, that of severe heat, no matter what the degrees of stimulation in the three different cases. Not only oscillations of temperature, but also mechanical and electrical stimulations, produced the feeling of cold at the cold points, and at the warm points the feeling of warmth. On the other hand, neither at the cold nor at the warm points did the prick of a fine needle cause a painful sensation.

The cold and the warm points were anatomically sharply defined, and were constantly found respectively at the same spots of the skin. On further investigation it was, however, ascertained, after taking observations several times of small sections of the skin, that, in consequence of fatigue and habituation due to repeated stimulations, the points very soon ceased to act; but, on being left for a considerable time in repose, they came decisively into operation again at the same spots. The localization of the sense of temperature was a highly developed one.

When one measured the least distance at which two cold impressions were felt distinctly from each other, it was found at spots which contained few cold points to attain a maximum of from 4 to 6 mm., while the minimum was 0·8 mm.

Dr. Goldscheider had made minute topographical studies on his own body in respect of the distribution of the points of temperature, and in general he had established that the number of warm points was less than that of cold points, that there were parts of the skin where neither cold nor warm points occurred, and that other parts contained indeed a few cold but no warm points, the glabella, for example. On the other hand, there was no spot on the surface of the body where warm points were found without the presence of cold points.

In the outspreading areas of the sensory nerves, especially in those of the facialis, warm and cold points were numerous; but they were sparingly found in the middle lines of the body, as also over the bones. In regard to the theory of the sensations of temperature, Dr. Goldscheider ranged himself on the side of Weber's view, and assumed that a rise of temperature in the skin generated the feeling of warmth, that is, excited the warm points, while a depression of temperature created the feeling of cold, by stimulating the cold points.

The experiments on the contrasting effects of temperature were very easily explained by this theory, when it was considered that each stimulation of the cold or warm points blunted them a little, and so rendered them more insensible to the next stimulation. Dr. Goldscheider, after the greater part of his experiments were concluded, received information that, previously to him, Herr Blix had demonstrated the existence of cold and warm points, and their electrical excitability; and, so far as these two independent series of observations covered each other, they completely coincided with each other in their results.

After the speaker had thus conclusively established the specific energy of the sense of feeling in respect of the sense of temperature, he applied himself to examine the sense of pressure by means of fine cork points attached to a spiral spring. He found the sense of pressure likewise distributed over the skin in the form of points; and the points of pressure, which coincided neither with the cold nor with the warm points, but occupied altogether special spots of the skin—the sites of special nerve apparatus—were also arranged in chain-like rows, these rows likewise radiating from particular points.

On the whole, the results in respect of the pressure points were found to correspond with those in respect of the temperature points, both as regards their distribution and the mode of their specific activity.

The localization of the sensation of pressure was still finer than that of the sense of temperature. The smallest distance at which two neighboring points of pressure could be recognized as distinct amounted to 0·1 mm. For the sense of pressure, therefore, just as much as for the sense of cold and warmth, the existence of specific nerve terminal apparatus provided with specific energies was demonstrated.

In reference to the sensation of pain, Dr. Goldscheider was of opinion that no special nerves were to be assumed. On the other hand, he thought that between the cold, warm, and pressure points lay the terminal apparatus of those nerves of feeling which produced specially the sensations of touch.

NEW SECONDARY BATTERY.

DR. KALISCHER lately described before the Physical Society, Berlin, a new secondary battery intended to overcome the disadvantage of the usual accumulators, namely, that the sheet of lead used as anode got very soon destroyed. This object he obtained by adopting a very concentrated solution of nitrate of lead as electrolyte, and iron as anode. The iron, on being immersed in the solution of lead, became passive, and resisted every corroding effect of the fluid; in other respects the peroxide of lead on the electric charge became deposited at the anode as a very firm, coherent mass, enveloping and protecting the iron on all sides. charge was continued until the greater part of the nitrate of lead was decomposed, a condition which was marked by the occurrence of a greater development of gas at the anode. At the beginning of the charge all development of gas must be avoided, as otherwise the peroxide of lead, or, more correctly, the hydrate of peroxide of lead, became covered with bubbles. As cathode a sheet of lead was used, but it was attended by two disadvantages:

In the first place, the lead, during the charge, separated itself at the cathode into long crystal threads, which soon passed through the fluid and produced short closing (of the current).

In the second place, the nitric acid, which remained in the fluid after the separation of the lead, acted very powerfully on the sheet of lead. Both disadvantages Dr. Kalischer avoided by amalgamizing the cathode. This accumulator of iron, concentrated solution of nitrate of lead, and amalgamized lead yielded, after the electric charge, which could be carried out without any special preparations, a current of about two volts; after about six hours' discharge, however, the electromotive force sank to 1·7 volts, but on the battery being left to itself for twenty-four hours, it became a little increased. According to the measurements hitherto

taken, the functions of this accumulator were satisfactory. An attempt to substitute sulphuric manganese for nitric lead in this battery did not answer the purpose, as the peroxide of manganese separated itself, not in a continuous layer, but in loose scales.

THE MARBLE PANELS OF THE FORUM ROMANUM.

THE marble panels, one of which is shown in the annexed cut, taken from the *Illustrirte Zeitung*, were found in the Forum Romanum during the great excavations of 1872. They are of white marble, and are 4 ft. 7 in. high and 18 ft. long Scientists disagree in relation to the original placing of these panels, but probably the opinion of one of the best known connoisseurs of Roman topography is correct, which is to the effect that said panels were used as ornaments on orators' platforms; which opinion is more or less verified by the representation on the panel shown in the annexed cut.

The panels are in an exceptionally good state of preservation, which can be accounted for by the fact that they were probably used in the construction of the Christian churches erected on the Forum Romanum, which churches were taken down in 1560. As the panels were used on a Christian church, there was no necessity of mutilating or destroying them. The panels are of the greatest importance for two reasons: First, in relation to the topography of the Forum Romanum, as the background of the panel shows the buildings of the Forum at the time of its greatest beauty and splendor. It is very difficult, and, in fact, almost impossible to define these buildings, as some of them are not fully executed, and some only indicated. On the left, and behind the speaker's platform, an arch is shown, and adjacent to the same a building resembling a temple, which, however, is provided with only five Corinthian columns, in place of six, as is generally the case. The building is probably the Curia. The empty space adjacent to this building probably represents a street. The arches to the right represent the Basilica Æmelia, built 53 B. C., by L. Æmelius Paullus, a building of which no traces have been preserved. The second point of interest in the panel is its historical value.

Both panels represent scenes from the life of the Emperor Trajan. In the panel shown, the Emperor is on a platform at the left addressing an assembly of men and youths, some of whom have their left hands raised. He is announcing the granting of an annuity by Nerva for the sons and daughters of poor people. In the right-hand side the Emperor is represented as sitting on a platform in front of a woman carrying an infant on one arm and leading a child with her right hand. This represents Italy thanking the Emperor for the benefits bestowed upon her sons and daughters. At the extreme right of the panel we find the statue of Marsyas and a fig tree.

THE MARBLE PANELS OF THE ROMAN FORUM.

FRESCOES FOUND IN ROME.

ARCHÆOLOGICAL discoveries of importance are rapidly succeeding each other here. That within the limits of the Temple of Vesta illustrating the rites performed there has been followed by another, made within the distance of a few yards, connected with the Christian Church and the ecclesiastical history of the tenth century (*circa*). It will be remembered that immediately behind the remains of the Temple of Castor and Pollux, and adjoining the church of Santa Maria Liberatrice, there stand the colossal walls of an edifice of brickwork of the finest imperial construction. What it was no one ventured to pronounce. The late Mr. J. H. Parker maintained that one of the walls belonging to it was part of the celebrated bridge built by Commodus across the Forum from his *domus* on the Palatine to the temple of Jupiter Capitolinus. Others have thought that these walls might be the remains of the temple dedicated to Augustus, which was somewhere in this vicinity. But these theories must be dismissed, together with others propounded in times past. Within and against the walls of this mysterious relic of imperial magnificence a number of hay-lofts have been built, hiding them almost entirely, except where they towered above the modern roofs. These hay-lofts, the ground floors of which were occupied by wrights and carpenters, are now in process of being demolished. Already the area of one great hall, with large niches for statues in it, and far exceeding in dimensions and grandeur any of the remains of the Forum adjoining it or of the Palace of the Cæsars above it, has been cleared. It was soon seen that the flooring almost corresponding with the modern level was of recent date. It was cut through. The original flooring was found at a depth corresponding with the level of the Forum itself. One-half of this hall has been further cleared down to that level, and from it opens a passage, the walls and ceiling of which are covered with comparatively uninjured fresco paintings representing Christian saints standing in rows on one side and the other, while on the face of the wall of the hall itself are remains of similar frescoes, indicating that it had been completely decorated in the same manner. The Commendatore de Rossi attributes these frescoes to the tenth or eleventh century, but for the present reserves any further opinion beyond that which he put forth in a tentative manner, with reference in part proof of it in a paper written by him on the eight hundred Anglo-Saxon coins discovered in a jar two years ago close to the House of the Vestals. This opinion was to the effect that at the time those coins were sent to Rome the imperial buildings along that side of the Palatine were occupied by the Pontiffs as their residence and by the officers of the ecclesiastical government as the Vatican is now. We must wait for the completion of Signor de Rossi's studies and researches regarding this interesting subject. But in the mean time one may be tempted to suppose that we see in this wall of an unknown edifice of one of the first Cæsars the hall, perchance, of the Consistory of the time of Alfred the Great, whose money was found near it. The completion of the excavations will, it is hoped, thrown full light on the original nature of this grand edifice of pagan Rome and the later use to which it was applied in Christian days. —*Rome Dispatch to the London Times.*

FIRE-PROOF BUILDING IN NEW YORK.*

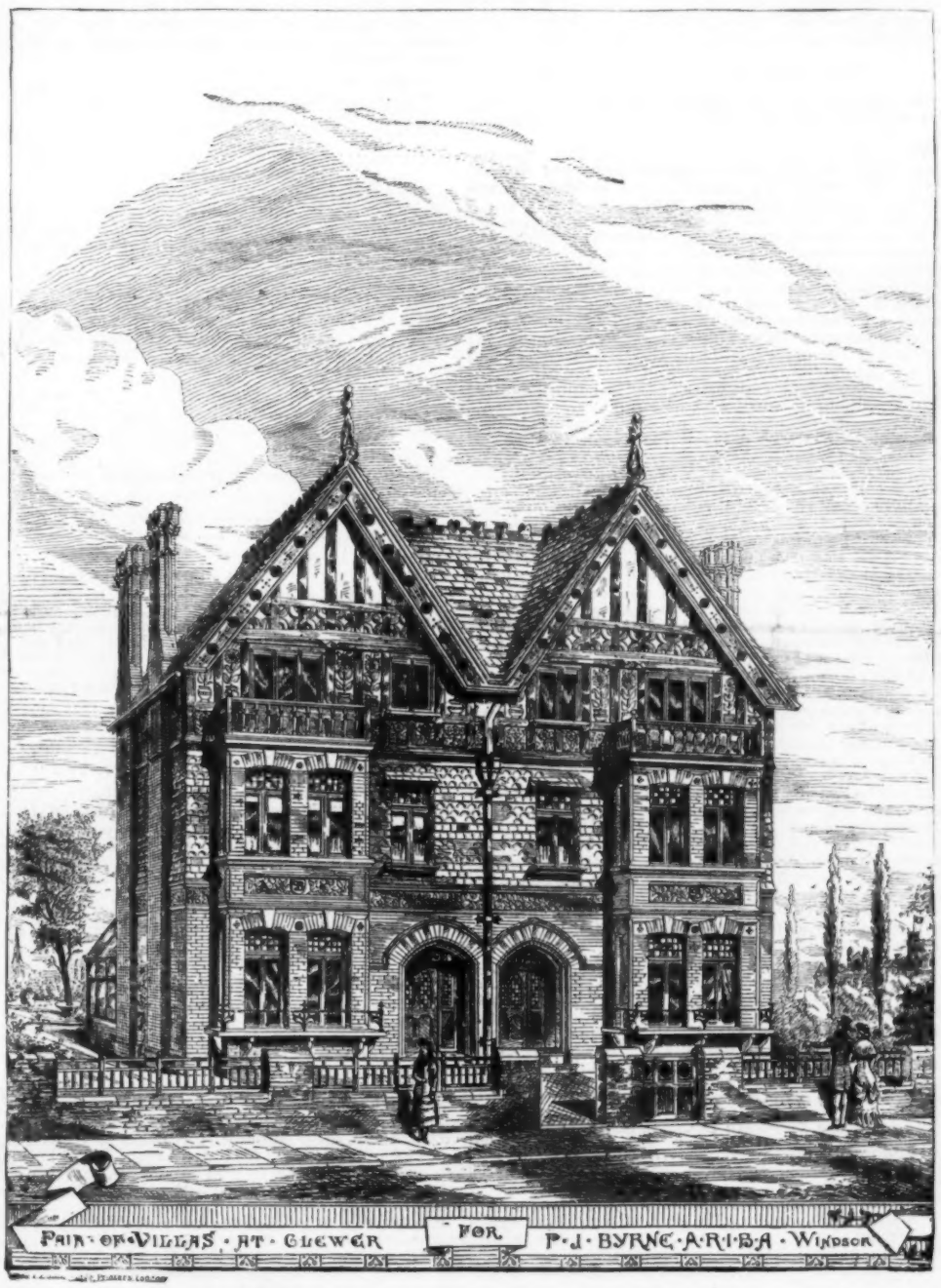
IN the construction of buildings intended to be thoroughly fire-proof, New York stands in advance of the whole world. London, Paris, Berlin, and Vienna contain some really fire-proof buildings, with floors vaulted in brick, heavy walls, and small windows; and many others ostensibly fire-proof, with plaster floors held up by a light frame of iron, everywhere exposed, and constantly liable, if attacked by the heat of a pile of burning goods, to a disastrous collapse, like that which destroyed in a few minutes one of the largest stores in Paris a year or so ago; but New York alone can show many buildings thoroughly light and airy, in which it is impossible for a destructive fire to occur. The essence of these buildings is, as it must be with our present materials, a structure of protected ironwork in which the whole framework is cased with terra-cotta.

The details of this sort of fire-proof work have undergone a good deal of modification within a few years, although the principles have not been changed. Not long ago a concrete of cinder and plaster was in high repute for filling between floor-beams, for partitions, for furring outside walls, and even for protecting iron, and various other concretes were much employed. These have proved, however, to be liable to crumbling from fire and water, and burnt clay is fast taking their place for all purposes. For furring, or lining outside walls, to keep the dampness of the brickwork from the rooms, the porous terra-cotta, or terra-cotta lumber, made by mixing saw-dust with fire-clay and baking it at a heat high enough to burn out the saw-dust, leaving a hard, spongy mass, is much preferred to the old-fashioned concretes; and the same form of burnt clay is used in thin blocks for forming partitions, which are so light as not to burden the floors, and at the same time strong and absolutely fire-proof, alternate heating to redness and saturating with water, many times repeated, having almost no effect upon it. For floors, burnt clay is now universally used in the shape of blocks, made hollow, to save weight, and tapered so as to form a flat arch, which has all the strength required, and has the great advantage of presenting a level surface beneath, which is corrugated, to receive directly the plaster of the ceiling. The old-fashioned brick arches, turned upon the lower flanges of iron beams, have now entirely disappeared from ordinary work, except for carrying sidewalks over coal vaults. To say nothing of the unpleasant appearance presented by a ceiling broken up into long, parallel ridges, this con-

* From a paper read before the Society of Arts, Boston, October, 1884, by Mr. T. M. Clark, and published in the *American Architect*.

struction, as usually seen, leaves the lower flanges of the iron beams exposed to heat from burning material in the room, thus violating the first principle of fire-proof construction as now practiced; and the attempts made in former times to support a flat ceiling below the arches, by means of iron lath, have always been very costly and unsatisfactory.

In the matter of protecting the lower flange of the beams, even the construction of flat arches of hollow blocks was not at first very successful. As will be seen from the upper diagram, in plastering on the underside of the blocks a space equal to the width of the lower flange of the beam, often four or five inches, had to be spanned by the mortar, with nothing to hold it against the iron. In this position it was likely to break away, especially in case of fire, leaving the iron exposed, and the latter blocks are made to hang a little below the beam, forming by their shape a dovetailed channel, in which a slip of terra-cotta is laid, when the pieces are put together, and is thus held securely. This gives perfect protection, but is a little troublesome, and the very latest blocks are made with projections wide enough to meet beneath the flange of the beam without the insertion of a slip. These blocks are as readily put in place as the primitive sort, and cover the beams



securely from fire as soon as they are set. Common as these blocks are now in New York, being the universal material for flooring in all new banks and office buildings, together with all the first-class apartment houses, and many private dwellings, they are as yet hardly known elsewhere, unless in Chicago, where fire-proof building is practiced with great success. Even in New York their use dates from very recent times, and it is said that in the construction of a building on Broadway, finished about four years ago, in which the architect required the floors to be laid with them, the masons, employed by one of the best contractors in the city, set them alternately upside down, so that they fell out when the staging was taken away from beneath them.

In England, the idea of the best architects is to obtain the effects they wish in fire-proof construction by the use of concrete. They have an excellent material in their Portland cement, and, by adding sulphur to it, the concrete made with it is rendered partially fire-resisting, by the lessening of its tendency to crack and crumble under the action of fire and water; but no concrete construction yet invented approaches, in the facility with which the materials are handled, the quickness with which the work is completed and the staging shifted to another place, or in the perfect security which it gives, that with the terra-cotta hollow blocks. By the help of these, and of the porous terra-cotta partition and furring blocks, a house with wide openings, floors ten inches thick from the level ceiling to the top of finished flooring, and partitions occupying different positions in the various stories, can be made just as secure against fire as a French or German storehouse, with its ponderous division walls extending from cellar to roof, and its vaulted ceilings two or three feet high from the spring to the crown.

ASPHALT ROOFS.

In describing a floor of a New York fire-proof building, we describe also the roof, which is made in exactly the same way as a floor, with iron beams, filled in and protected by hollow terra-cotta blocks, which are then leveled up with concrete, two, three, or four thicknesses of asphalted felt laid on the top, and the whole then covered nearly or quite an inch thick with rock asphalt, precisely like that used for paving the streets of Paris, and put on in the same way. Once put down, on a sufficiently rigid framework of beams, such a roof is as permanent as the building itself. The heat of the sun does not affect it, water runs off it as from a granite slab, and the movement upon it, even of horses and carriages, would deteriorate it very slowly, if at all. With these roofs, the flashings, even though of copper, are the weakest part, and in the latest of the great fire-proof office buildings the flashings themselves are replaced by great slabs of rubbed slate, set vertically around the parapet walls, the lower edges of which are embedded in the concrete, while the wall itself is built out over the upper edge, holding it like a panel. It is difficult to see where the deterioration of a structure like this could begin. Centuries must elapse before either the asphalt roof covering or the slate flashings would decay far enough to admit water to the interior, and extravagantly costly as the construction appears, it will probably be economical in the end.

It is usual in all these fire-proof buildings to lay a wooden floor for comfort in walking, and this is now universally put on wooden sleepers, which lie on top of the terra-cotta blocks, and are held in place by having their ends so shaped that they can be wedged under the upper flanges of the iron beams. After these are in place, the space between them is entirely filled with cinders, and the wooden flooring is then nailed down. By filling the intervals between the sleepers with cinders, the circulation of air under the floor is prevented, and although it would perhaps be possible to burn a hole in the wooden floor by building a fire upon it, the fire could not spread, and experience shows that the currents of air around a fire draw so strongly upward that there would be no danger of heating the iron beams in this way sufficiently to do any harm; while the cinder-filled space, three or four inches in depth, affords an opportunity for carrying steam and water pipes under the floors from one part of a room to another, as is generally necessary in apartment houses and office buildings.

THE BOWER-BARFF "RUSTLESS IRON."*

By J. H. KIDDER, M.D.

Mr. President and Gentlemen:

I have here some specimens of iron treated by the Bower-Barff process, or, in other words, artificially coated with magnetic oxide.

These specimens were sent me by the Commissioner of Fish and Fisheries for examination and report as to the probable availability of the process for the purposes of the Commission, as applied to pipes immersed in salt water.

It has been known for a long time that magnetic oxide of iron is practically insusceptible to rust under ordinary conditions. Lavoisier is said to have observed the fact, and described a method for the artificial production of the oxide. The black titaniferous sands of New Zealand are almost wholly composed of magnetic oxide of iron, and have withstood the action of sea-water probably for centuries. Berthier noted its formation upon iron exposed to superheated air, and Thirault is said (in 1860) to have invented the process whereby gun barrels are coated with the oxide and protected against dampness and rust. It is a familiar fact, too, that Swedish and Russian sheet iron are little subject to rust, and Dr. Percy pointed out several years ago the fact that this immunity is due to the accidental production of a coating of magnetic oxide in the process of manufacture.

Some time prior to the year 1876 Professor Barff, in the course of some experiments upon heat formation, noticed that magnetic oxide was formed in a pipe used to carry superheated steam; and, following up this hint, perfected and patented his process for the artificial protection of iron on a large scale. According to the Barff process, iron is strongly heated in closed chambers and exposed to superheated steam. Magnetic oxide is formed, and hydrogen set free. The process is entirely successful, but rather costly, owing to the expenditure of fuel in heating the iron to be operated upon.

About the year 1880 Mr. George Bower, assisted by his son Anthony S. Bower, patented another and cheaper process. By the Bower process the products of the distillation of coal, containing much carbonic oxide, are brought into contact with highly heated atmospheric air in slight excess of the quantity required to oxidize it. The resulting carbon dioxide, together with the small excess of air, all raised to a very high temperature by combustion, pass into a chamber containing the iron to be treated, which is heated by contact with the hot gases. At about 1,600° F. the iron takes oxygen from carbonic acid and the small excess of air, and becomes coated with magnetic oxide overlain by sesquioxide. This treatment is continued for about half an hour, and is called the *oxidizing process*. It results in the formation of a coating of sesquioxide, or rust. At the end of the time appointed the air inlet is closed, and only carbonic oxide admitted for 20 minutes more. By this, the *reducing process*, carbonic oxide is converted into carbon dioxide, and sesquioxide is reduced to magnetic oxide.

According to a recent paper by Mr. B. H. Thwaite, read before the Institution of Civil Engineers, six repetitions are desirable for articles to be used indoors, and from ten to twelve for articles to be exposed to the weather. According to the same authority, the thickness of the coating varies from 0·0035 to 0·02 inch. Mr. Flamache, engineer for the Belgian steel railways, has reported the cost for the process, exclusive of royalty, as 7¼ francs per 1,000 kilos. by weight, or ⅜ centime for the surface of a cubic decimeter.

Mr. Thwaite thinks that the Bower process produces the oxide too rapidly and in not sufficiently uniform or coherent layers, and regards the Barff method as preferable for wrought iron or steel. The least admission of air during the deoxidizing process will produce an imperfect and unstable coating.

The Barff patent has been purchased by the Bowers, and there is now an American Bower-Barff Rustless Iron Co., with offices at 35 Broadway, New York.

This specimen (A), a short iron tube with a male screw thread on each end, has been immersed in sea water for 38 days, in an open jar, at an average temperature of 70 degrees. The sea water was clear and without sediment, and had been brought from the surface of the Gulf Stream, about forty miles east of Cape Hatteras. Its specific gravity was 1026·1. At the end of the experiment the water was thick with sesquioxide of iron, and the specimen distinctly rusted, particularly in the screw threads. One side remains clean, corrosion being confined to the side opposite, suggesting galvanic action. An iridescent pellicle upon the water contained many bacteria (mostly *B. termo*).

This bent coupling (B), with female screw thread in each end, was immersed in tap water, in a closed jar, the time of exposure and conditions being the same as those governing the other experiment. At the end of 38 days this specimen had also rusted, but the rust was confined entirely to the screw threads and to a file-mark upon the convex surface of the pipe. The quantity of sesquioxide was much less than in the experiment with sea water.

The authorities of the Plymouth (Eng.) Dockyard have reported that this magnetic oxide is subject to galvanic action when immersed in sea water, in presence of unprotected iron. To test this question (of galvanic action) other specimens were obtained, in the form of cylinders ½ inch thick and of strips ¼ inch wide by ¼ inch thick. The sheared ends showed a little sesquioxide, and were protected at first by red sealing-wax, but afterward by beeswax, considering the possibility of the presence of cinnabar in the sealing wax.

Two of these cylinders or strips were tied together with platinum wire for one element, a similar surface (about 16 sq. inches) of unprotected iron for the other element, and clean sea water from forty miles off shore (sp. gr. 1027) used as the exciting fluid. Several cells

* Read before the Chemical Society of Washington, D. C., April 10, 1885.

were thus constructed, the circuits closed, and allowed to remain so from two to five days.

In every cell the galvanometer indicated a decided current, its direction within the cell being from unprotected to protected. Magnetic oxide is therefore electro-negative to iron, like sesquioxide and protoxide, of which it is sometimes supposed to be compounded. The unprotected (positive) element lost weight, and remained clean so long as immersed, excepting for a thin, greenish, semi-gelatinous film (hydrated ferrous carbonate). The cell fluid became densely turbid with sesquioxide, and in three out of four cells little lumps of sesquioxide adhered to the protected element, and were found to cover spots of disintegration of the magnetic oxide. In one cell only the protected surfaces remained unaffected after seventy-two hours of closed circuit, the cell fluid being densely turbid by accumulation of sesquioxide.

The action here appears to be nothing more than a very vigorous rusting of the iron, and confirms the generally received explanation of rust as a true galvanic process, set going by the intervention of carbon dioxide and oxygen dissolved in the water, and kept up by electrolysis. In these cells the hydrated ferrous carbonate which marks the first step of the process appeared in sufficient quantity to be easily visible.

When, in another cell, four per cent. hydrochloric acid was substituted for sea water, galvanic action was much intensified, and both elements were attached, the unprotected more actively than the protected.

When, in a sea water cell, copper was substituted for unprotected iron, the direction of the current was reversed, and the magnetic oxide rapidly decomposed. Iron was found (after fourteen hours of closed circuit) deposited upon the copper plate and in solution in the cell fluid. No copper was found on the surface of the iron or in solution.

It appears from these experiments that, although there is abundant evidence that the magnetic oxide of iron is not susceptible to the action of sea water, the specimens presented for examination were not thoroughly coated. The screw threads broke down first, while some parts of the surface showed no sign whatever of corrosion.

Galvanic action ensues vigorously when protected and unprotected iron are immersed together in sea water, but always at the expense of the unprotected iron; so that, if the coating be thorough and homogeneous, there is nothing to be feared from the neighborhood of unprotected iron.

The neighborhood of copper, which is electro-negative to magnetic oxide, determines the rapid oxidation of the latter, and the loss of its protective power against ordinary agencies. The presence of zinc, tin, or lead would probably be protective to the magnetic oxide.

When two of the cells described were connected in series, there was scarcely more current force than had been shown by each cell singly. It appears to be probable, from observation of the cells, that the direction of the current within the cells was from iron to ferrous carbonate, to sesquioxide, to magnetic oxide, each substance named being electro-positive to that which follows it. It is known that both sesquioxide and protoxide of iron are electro-negative to the metal itself, and I am disposed to regard them, or at least the sesquioxide, as occupying an intermediate place in the galvanic series between ferrous carbonate and magnetic oxide. From these internal currents the resultant electro-motive force of the battery was much weakened, the cells being "polarized," and the galvanometer indicating much less than the amount of galvanic action which actually occurred.

THE METHOD OF MAKING SOAP—LAUNDRY AND TOILET—WITH FORMULAS.

By an EXPERIENCED MANUFACTURER.

THE tide of improvement which has so vividly marked the past fifty years has lifted in its course every branch of industry. It is difficult now to designate with justice to what source the most credit is due, but we will not err far if we give a large share to the thoughtful workman. Wishing to improve the character of his work, and make more gain, he has noted the open port, and if beyond his reach has applied to the mechanical inventor or to the forward men in chemistry or art.

By such means the knowledge and arts of the ages past are brought into combination, making our own land a point to which men look for things new and marvelous. This may seem too stylish an introduction for so plain a subject as soap, but to those who, like the writer, have seen the advance of the science in the past fifty years, the only fear will be that these few pages will not do the subject justice. We will now commence on the practical part.

What we consider the first requisite in this manufacture is purity of material. Some think anything will do for the common soap kettle, but if you wish to make an article that will keep the market, make it good. Self-interest will dictate this. Remember that what you make goes into the hands of the best of judges, the American woman.

The next point is proper appliances to work with, if you are not already supplied. There is no easier or better way of learning what is foremost in any business than to get a few numbers of the SCIENTIFIC AMERICAN SUPPLEMENT, bearing on the subject, and when you get them, cut out what you want and make a book of them. Select your plant with care, buy nothing you do not need to start with, or of which you do not know the use in your case. Employ as good a soap maker as you can, but keep memoranda of all that is done, and verify by results.

If you require to start in a small way, three kettles and a tank for lye will be requisite—one kettle to hold about six thousand pounds, and two of six hundred pounds—with a boiler to make steam; the large kettle is heated by a coil at the bottom, the two smaller to be what is known as jackets. You will require say five frames to hold the soap, each to hold one thousand pounds; wooden frames are still used; some prefer the iron, though more costly. The wood should be lined with zinc.

You will also require a platform scale. Soap is a heavy article, and unless you are on a ground floor, you will need a steam hoist. You are now ready to make your lye.

Take one drum, about 600 pounds net, of English caustic soda, and break up the contents by beating on the case. When well broken, knock off the ends, and the case will fall apart. Have your hands greased, and look out for your eyes.

Let in water into each of the small kettles until they are about half full. Now, with a shovel put the soda equally into each kettle, put on steam, and boil, keeping the kettles about full of water. Stir up the soda with an iron poker, and boil until all is melted, finish with the water full up, let the solution stand for two days, then bail off into a tank large enough to hold the contents of both kettles. The sediment at the bottom is waste, not suitable for making soap.

When the lye is in the tank, float the surface with a little oil to prevent change from the action of the atmosphere. You will find this lye to weigh about 38° Baume, the alkalimeter generally used by the soap maker, and to cost you not more than two cents per pound.

You are now ready to make soap, and we will give first as

NO. 1.—WHITE BOILED SOAP.

Formula for 5,000 lb:	
Tallow	2,300 lb.
Cotton seed oil	100 "
Cocoa oil	50 "
Lightest rosin	50 "
Soda lye at 36°	1,250 "
Water	1,250 "
Total	5,000

By careful calculation this will cost 4½ cents per lb. Allowing for labor and boxing, it retails for 10 cents per lb.

The process of making is as follows: Put into the large kettle all the tallow oil and rosin, put on the steam and melt, at the same time put in 50 lb. of the lye and about half the water, thus starting with weak lye—10°; the tallow will shortly neutralize the lye, or as we say, take it up, making a smooth, pasty fluid. When this occurs you must put in more lye and water, which you are to continue as the soap smooths until all the lye and water are in, and then comes the finishing, which is the grand point in all chemical operations, for, as a careful manipulator has said, chemistry is a treacherous jade. Why? Because we are not sure of the actual receptive quality of the tallow, or of the actual soap-making properties of the lye we have bought. Now, how shall we get over the difficulty? By patient, watchful study and attention, and we will point out the symptoms of the case; if, after all, the materials in the soap samples look smooth, have no firmness, and no taste of lye, then it is too weak, and you must add more lye at 36°. Put in about 10 lb. at a time, and wait a quarter of an hour, putting in more carefully each time, and you may thus get in 50 lb. each of lye and water above the amount of formula. Take out a pound as sample, and let it rest, keeping it warm until the next morning, when you must decide upon the case; if too strong, you can add some tallow or oil. Keep memoranda of all you do, and put it down in your book, with cost of soap, time, and labor.

A good way to handle the soap the next day is first to draw off through the spigot at the bottom of the kettle the spent lye and unsaponifiable substances that lie at the bottom of the kettle, replacing their bulk in the kettle with fresh water and about 10 lb. of lye, heating up the soap. When remelted, you can judge by tests above given if the soap has proper strength. If not strong enough, correct by rule given and cover up, keeping warm until the next morning, when it is ready to frame.

If you have a steam crutcher, put it through that; it makes the soap more homogeneous, and gives the best opportunity of putting silicate, borax, or carbonates, as well as perfume, if such is desired. When in the frame, the body should be kept in motion by hand crutch until too stiff to work. The use of silicate, etc., will be treated separately.

The above is the whole history of a batch of soap. All variations from formula do not materially affect the process.

FORMULA 2.—ROSIN LAUNDRY SOAP.

There has always been a popular prejudice in this country against rosin soap, based no doubt upon the fact that rosin being very cheap, the manufacturer would sometimes get in too much. During our civil war, however, when the supply was cut off and it was dear, we learned that we had underrated our old friend, and now we are glad to recognize its merit.

No. 2.—Rosin Laundry Soap.

Tallow (first quality)	1,800 lb
Palm oil	50 "
Cocoa oil	50 "
Rosin; lightest	600 "
Soda lye 36°	1,250 "
Water	1,250 "
Total	5,000 "

The treatment of this formula is the same as No. 1. It will make an excellent lather, and if the lye has due proportion, can be depended upon for all purposes; it might well be called the standard soap of America.

FORMULA 3.—PALM SOAP.

The odor and color of palm oil are well known, and properly used it is a valuable stock. There is a difficulty in getting rid of the excess of color, which is a stain, without impairing the saponaceous properties of the oil. I recommend to melt the oil on purchase and first settle out the crude coloring matter. In heating up put in one pound of chromate of potash or the same of muriatic acid to each 200 lb. of oil. After settling, take the clean oil, and by the following formula make up into soap, the process being the same as in No. 1:

Palm oil	1,000 lb.
Tallow	1,000 "
Rosin	500 "
Soda lye at 36°	1,250 "
Water	1,250 "
Total	5,000 "

This palm soap is most useful as a base for the finest toilet soaps. If the amount of rosin is considered in excess, you can when milling mix some of No. 1 with it, but as given it is good for bath or general toilet.

We will now give one more formula for a

No. 4.—Rosin Laundry Soap.

Tallow (second quality)	1,700 lb.
Palm oil	50 "
Cocoa oil	50 "
Rosin	700 "
Soda lye 36°	1,250 "
Water	1,250 "
Total	5,000 "

The cost of these four soaps runs from 3 to 4½ cents per pound, boxed for market.

With these four formulas we close the list of settled soaps, remarking that they can be made cheaper by adulterants, but not better.

Little Pan or Glycerine Soap.

The making of this soap is interesting, and the soap when well made cannot be excelled, mainly for the reason that the glycerine natural to the tallow and oils used is retained in the soap. The method was perfected in England forty years ago, and gave to their soaps the efficient character they still maintain.

The tallow and oils should be melted with the rosin, settled and strained to purify them. The lye also should be well settled, so that it contains no foreign salts. Take of:

Tallow	210 lb.
Cotton seed oil	20 "
Light rosin	20 "
Soda lye 36°	125 "
Water	125 "
Total	500 "

Make in a 600 lb. pan. Commence with 5 lb. of lye and 25 lb. of water. Start in the afternoon, and finish at two P. M. of the second day. Perfume in the frame.

COLD SOAP.

This method, though but little practiced now, is worthy of a place, if for no other reason than that it contains the chemical index of the average proportion of lye to the tallow and oils used. The following will be a good example:

Tallow	80 lb.
Cocoa oil	10 "
Rosin	10 "

or double the amounts:

Melt to 100° F., and then pour in slowly, and stirring moderately,

Soda lye at 36°	45 lb.
Potash	5 "

or double, as above.

As the body cools off, the different components will combine some or get smooth. Pour into a frame lined with muslin, and cover. A chemical heat now takes place, which finishes the combination of the soap. This soap must be cut in twelve hours, and can be pressed in one day after.

POTASH COLD SOAP, OR PEARL SHAVING CREAM.

No shaving cream is more perfect than this, and no other makes so fine and durable a lather. Take:

Tallow	95 lb.
Cocoa oil	5 "

Melt to 100° F., and then pour in gradually, stirring continuously, 55 lb. potash lye 36°. The soap will stiffen up during the day, when it should be poured into a clean lard cask and kept for two weeks. By proper manipulation in mill or mortar, it becomes silky and is ready for perfume, the formulas for which will be found at the close of this article.

The small kettles are also used in making pumice soap, and for the purpose of cleaning wood and marble.

KITCHEN CRYSTAL SOAP.

The formula for Poncine is as follows: To each 100 lb. of soap—say No. 2 or fine laundry—put in 50 lb. of pumice; it can be put in while hot, and then cut into strips, dried, and milled. The kitchen crystal is cut from the frame into 1 lb. lumps. It has a ready sale, and is very useful.

We should say here that the soaps made as above, except the cheapest rosin soap, can be perfumed and colored by turning them into the 500 lb. kettles and cutting them, after framing into cakes of convenient size, and pressing them for toilet soaps. It has become the custom, however, to mill all toilets, and we will proceed and give the method with perfumes for various kinds.

It is in preparing toilet soaps to suit a fastidious and cultivated taste that the art has reached its highest point. When we examine the styles and perfume of the variety offered by the Paris manufacturers, and the elegance of their finish, we feel that when we equal them we may claim credit.

Their success has stimulated competition, and we now have several well established houses who feel that they can command the home market.

In giving our formulas for a few fine milled soaps, we do not propose to put in any artificial color, but trust to effects of the material used for any variety wanted. The day has gone by when the buyer expects that because a soap is colored with vermilion it is made from roses.

MILLING AND PLODDING.

In this day, when perfection in results and economy in production are both necessary to success, it is not proper to pass without due notice the great advantage in the use of machinery in the preparation of fine toilet soaps for the market, and both the milling and the pressing are entitled to special notice. Twenty-five years since, the small amount of extra-perfumed soaps made in this country could be and were to some extent worked up in a large mortar by hand, but this was found both insufficient and costly. It therefore was not long before the grinding mill with marble rolls was introduced from France, and with it also the machine called the plodder, into the chamber of which 200 lb. of the milled and perfumed soap is put, and then by

the aid of powerful pressure forced through an opening at one end, of sufficient size to suit the shape of the cake into which it is to be pressed.

A mill and plodder will turn out in this way 1,000 lb. per day, in such condition that it may be pressed in twenty-four hours. One advantage of milling is that the costly perfumes used in scenting are not wasted by exposure in drying the soap, nor do they pass out much when packed together. Another gain is that in continuous operations there is but a fractional waste by scraps, as is the case in cutting and pressing solid soap. But the great gain is in the improved style of the soap and permanence of shape in the hands of the dealer, for though it don't hurt soap to get crooked, it will not sell so readily.

PRESSING AND PACKING.

There comes a time in the experience of every manufacturer when he sees that there must be improvement in his method of making or selling, or he will have to take a back seat. This is not a pleasant thought, but the fact that he does see it is hopeful. It has been but a few years since that certain London soaps led the market, and the jobber or retailer felt that he must have them; but the introduction of the French machinery into this country, and its improvement, together with the work and attention of our foremost men, has made a change in the wants of our dealers. Now they must have certain American soaps, and can do without the imported. And it is but just to say here that, though our industries are fostered by our duty on imports, we now get as a return, or rather give to our fellow citizens, equal goods at cheaper rates. This certainly is the case in toilet soaps, as can be ascertained by inquiry.

We consider the above as due to the present workmen, and as encouragement for the future.

The soap being now brought forward as ready for the press, it is important that you select the best, and we again refer you to the information bureau of the SCIENTIFIC AMERICAN. When the soap is pressed to shape and size decided upon, you must take up the art of packing, in which style, convenience, and cost must all be carefully considered: Some buyers want only the soap, others will pay for appearance. Suit both if you can with as few styles as possible.

Our boiled white soap and the palm soap can be relied upon for the finest perfumed soaps, and to prepare should be cut up into thin slabs and put in a room where they can be dried without danger of dust. Having selected your milling apparatus, consisting of cutter mill and plodder, take of the white boiled soap, now bone dry, and weigh out say 200 lb. After chipping, put through the mill at least three times; at the second add to each pound say ten cents' worth of the following formula for white rose soap, put through the plodder, and cut to size and press into shape desired:

Otto rose	1 oz.
Oil geranium leaf	1 "
Oil Turkish rose	6 "
Oil sandal wood	1 "
Oil cloves	2 "

West End Bouquet, No. 1.

Extract benzoin	16 oz.
Oil lavender fine	16 "
Oil bergamot	16 "
Oil cassia	½ "
Oil sandal wood	16 "

The soap selected for the West End and Jockey Club should be half each of the white boiled and the palm.

Sweet Brier Soap, No. 1.

Turkish rose	16 oz.
Oil geranium leaf	4 "
Oil cloves	2 "
Oil sandal wood	4 "
Oil bergamot	16 "

Note.—A good variety in color can be made by adding to 1,000 lb. of the palm soap, before finishing, say 20 lb. of glucose, which in the hot soap turns it to a light chestnut color, and makes the soap more emollient, acting like honey.

Jockey Club Soap, No. 1.

For the body take the palm soap that has been colored with glucose, and mill into it these oils at ten cents for each pound of soap:

Oil bergamot	16 oz.
Extract musk	16 "
Sandal wood oil	8 "
Turkish rose	8 "
Oil patchouly	4 "
Oil lavender	8 "

Benzoin Soap, No. 1.

Extract benzoin	32 oz.
Oil lavender	16 "
Oil bergamot	8 "
Turkish rose	4 "

These five formulas are deemed sufficient for experiment in fine milled soap. Select what you prefer, and make a specialty of it. Our preference is the Metropolitan Bouquet.

Bouquet Metropolitan, No. 1.

This formula contains the oils that make one of the most salable of toilet soaps.

Oil bergamot	16 oz.
Oil geranium leaf	16 "
Oil Turkish geranium	16 "
Oil sandal wood	8 "
Oil Lebanon cedar	8 "
Oil lavender fine	8 "

FOR SOAPS OF LOWER PRICES.

We prefer as soaps designed for every day use to use a body that for detergent properties will suit every want. Such soaps you have in formulas No. 2 and 3, and if it is so desired these can be cut into convenient sized cakes and pressed without milling; for these and for the cheaper milled soaps the following five receipts are given.

Old Brown Windsor Soap.

Probably no soap held its own so long in our market as the English soap of this name. It is a remelted soap, the perfumer selecting his stock from the London market, remelting, and perfuming it well with the essential oils about as given below. The soap is cut into square cakes, finished and stamped by hand, a process too slow to pay now, not making a good shape.

Perfume for Brown Windsor Soap.

Oil red thyme	4 lb.
" caraway	2 "
" lavender	1 "
" cassia	½ lb.
" sandal wood	¾ "
" bitter almond	⅛ "

Almond Soap.

Use the boiled white soap for this, and perfume as below. *Note.*—The ess. mirbane being very strong, be careful and not use too much.

Ess. mirbane	1 lb.
Oil citronella	1 "
" caraway	1 "

Honey Soap.

The perfumer of soap has been in the habit of trying everything suggested to improve his soap or its perfume, and the writer has ancient manuscript formulas gotten out originally to suit the select few; among these honey is given, and its use in soap for the hands commended.

Perfume for Honey Soap.

Oil citronella	4 lb.
" red thyme	1 "
" caraway	½ lb.
" cassia	¼ "

Use No. 2 formula of soap for this, and the color will be about right.

Transparent Soap.

This soap when well made always finds buyers, and at different periods some one makes a specialty of it; there are old and new methods for making it, and a number of formulas for making it without alcohol, but no first class article is made without spirit of some kind. We give below three formulas, but the cost and the care required needs the experience of special training. Take:

Rosin soap	50 lb.
White "	50 "
Alcohol	50 "

The soap being chipped up and dried properly, dissolve in a tight vessel in a steam bath; when dissolved, distill off the surplus alcohol, the amount being a question of experience, and let the soap settle for four hours, then pour into moulds.

Transparent Soap by Direct Process.

Sample lot.

Tallow	50 lb.
Soda lye 36°	21 "
Alcohol	4½ gallons.
Syrup white sugar dissolved in 4 lb. water.	5 lb.,

The tallow to be melted, and the lye and alcohol mixed and poured in together, the syrup to be added last.

Perfume for Transparent.

Oil caraway	1 lb.
" lavender	1 "
" cassia	¼ lb.
" citronella	⅛ "

These soaps are also called glycerine soaps, the warrant for which is found in the fact that glycerine can be introduced in them, as it readily unites with the alcoholic soap, and gives a softening influence when used.

Borax Soap.

Borax is beneficial to soap; it has the property of cleansing without injury to the fabric. It is generally made as a white soap, and the following is a good formula for a 5,000 lb. lot:

Tallow	2,000 lb.
Cotton seed oil	300 "
Cocoa oil	150 "
Rosin	50 "
Soda lye 36°	1,250 "
Water	1,250 "
	5,000

When put into the crutcher, add to each 1,000 pounds 10 lb. of borax in solution, 10 lb. of silicate of soda, and mix well.

Ammoniated Soap.

To best rosin laundry soap add when put in the crutcher two pounds of sulphate of ammonia pulverized. The heat and the water in the soap will make the solution, and the lye in the soap will transform the sulphate into volatile ammonia, which will be noticeable in the soap for some time.

Tallow and the Various Oils.

The chemist has divided all such material into the four familar parts known as oleine, stearine, glycerine, and margarine; and in the making of soap each has it uses. It has however been only in recent years that the valuable properties of glycerine were retained in the soap (see glycerine soap in this article). Without doubt to these separate principles are to be attributed the distinctive character of various soaps. We will not go into a question so deep as the cause, but give general views in regard to selection.

As our country now gives prices to the world for beef, so the tallow of our Western country supplies the bulk of stock for the soap maker, or dictates the price in our markets.

Beef tallow, or what is known as shipping grade, is the most reliable, and will, we think, make more true soap than any other grease, with the single exception of cocoa oil, which has the property of holding more water and lye in combination, but which has also the serious objection of becoming rancid to an offensive degree, and consequently of being injurious to the skin; no means have yet, after diligent search for years, been found to prevent this defect. Of palm oil we have treated in connection with palm soap.

Lard makes a poor lather and is costly, and this brings us to cotton seed oil, which, being a home product, deserves attention. When first brought into use, much was expected of this oil; it made into soap easily, was emollient, and retained a fair color, and we were disposed to think that we had at last found a match for the imported white Castile soap; but in the hands of all makers time brought disappointment. In the course of a few months it was noticed that the soap had absorbed all the lye, and had become rancid, and to the present time the difficulty still presents itself. Notwithstanding the objection to these two oils, you will find them in most formulas, kept there for their valuable properties, the substantial qualities of the tallow and rosin neutralizing the danger noted.

Similar danger exists in using new material of any kind; these are offered under the plea of economy or superior fitness, but the risk falls upon the manufacturer—risk of reputation, as also of labor and money.

The soap adulterants number a dozen or more, while two or three would cover the whole proper ground; alkaline earths and silica, fine or coarse, have their uses, but care should be taken not to abuse them.

Sal Soda.

This is one of the most commonly used chemicals in soap; it thickens it, and keeps it firmer for a time, but ultimately its value is doubtful in a well made article, and it has the fault of promoting efflorescence, which gives a cheap look to the soap, and is noticed by every buyer.

So large is the business we have been describing, and so varied its products, that the limits of a newspaper article can do it but limited justice; there is one thought we must give to the young and enterprising, which is that this country, with all its achievements, has really just begun; and we could give an instance of a manufactory in a German city but seldom named that employs as many as forty presses to press its soap.

Of Starch, Talc, and Silica.

These are used as filling for the second grade of solid soaps; the first has an emollient effect, the latter are detergent, acting mechanically.

Heat.—The importance of heat must be noted, and its effect studied. A portion of the time in making, the soap will do well with 100° or 200° F., but before finishing it must be well cooked.

Arrangement of Plant.—This will depend upon the situation; much can be done by proper consultation to economize both space and labor; a properly organized factory will have both light and air; the raw material should go in at one end, and travel steadily through until it reaches the room for finished stock.

Perfume for laundry soap is an innovation; care must be taken that it is not objectionable; pure material is sufficient.

This closes a brief but, we think, a clear account of an important and still profitable business.

ANDERSON'S WATER-PURIFYING APPARATUS· INVENTIONS EXHIBITION.

THE apparatus illustrated by the accompanying engraving is shown by Messrs. Easton and Anderson, of Erith. This exhibit illustrates in a complete manner the new process of purifying water by means of iron. Some twenty-eight years ago Dr. Medlock first called attention to the remarkable power iron possessed of removing color and destroying organic impurities in water, and Professor Bischof has labored persistently in endeavoring to apply the process both to domestic use and to water supplied on a large scale. The spongy iron domestic filters enjoy a well-deserved reputation, and the bold attempt to purify the waters of the Nethe, from which the supply of Antwerp is derived, by filtration through a mixture of gravel and spongy iron, has met with very marked success, so far as the effect on the water treated is concerned. The objections to Professor Bischof's process on the large scale is that a very considerable area of land is required for the filter beds, that the cost of the iron in them is very great, and that some trouble and expense are incurred in the periodical cleaning of the surface of the iron mixture, a process which necessitates the removal of the layer of sand over it.

The apparatus exhibited is intended to overcome the difficulties and objections above described. This is effected by abandoning the principle of filtration altogether, and resorting to the method of agitating, or mixing continuously, a comparatively small quantity of iron with the water, which, after treatment, is suffered to stand for some time, in order that all the iron dissolved may become oxidized, and is then passed through an ordinary sand filter, or allowed to get clear by subsidence. The general arrangement of the exhibit is the following: The water from one of the cascade basins is forced by means of a duplex pump through a revolving purifier into a tank placed 17 ft. above the ground, and fitted up as an ordinary sand filter. The purified and filtered water is conducted by a galvanized wrought iron pipe to the fountain in the Austrian Court and to the drinking fountains; while the overflow, which is purified, but not filtered, falls on to a small water wheel, by which the revolver is turned, and then flows away by subterranean culverts to the centrifugal pump which operates the cascades.

The Duplex pump, by means of which the water is raised from the cascade basin, is no other than the Worthington pump, which has recently attracted so much attention as a new importation from the United States. It is, indeed, an American invention; but Messrs. Easton and Anderson acquired the patent at the time of the 1862 Exhibition, when the pump was first shown, and have manufactured large numbers of greatly improved design since. The pump, which is capable of delivering 100 gallons per minute, consists of a pair of steam cylinders, 5½ in. diameter, 12 in. stroke, each actuating directly an ordinary double-acting pump 3½ in. diameter. Steam is distributed by common slide valves; but the steam ports are double, one pair opening into the cylinder some 1¾ in. from the ends and the other pair at the extreme ends in the usual manner. Steam is admitted by the outer passages and exhausted by the inner ones, but the piston is so constructed that it passes the cylinder openings of the inner passages, and by so doing closes them and imprisons a cushion of steam. The cylinders are steam jacketed, so that the cushion is effective up to the full pressure of the steam in the jackets. The valves are

placed on the sides of the cylinders, and worked direct by levers actuated by studs on the piston-rod cross-heads, the piston of one cylinder actuating the valve of the other. The effect of this arrangement is an extremely simple machine, which will start and stop by simply opening or shutting a cock on the delivery main of the pump.

Pumps of this kind have been extensively used for the supply of towns, such as Wisbech and Huntingdon, and for providing water under high pressure for working cranes, hydraulic presses, and riveting machines, etc. They pump direct into the mains, and produce a pressure varying from 73 per cent. of that due to the steam when working full speed to 94 per cent. when brought up standing by the water being all shut off.

The patent revolving purifier consists of a cast iron cylinder 2 ft. 6 in. diameter, 5 ft. long, with closed ends fitted with hollow trunnions, through which pass, through stuffing boxes, the 3 in. inlet and outlet pipes. The inside of the cylinder is furnished with six curved shelves or ledges the office of which is to catch up the iron placed inside the cylinder, and shower it down continuously through the water slowly flowing along. The iron, which may be of any kind in a finely divided condition, cast iron borings being the most effective, occupies about one-tenth the volume of the cylinder, and in this particular case weighs 2 cwt.

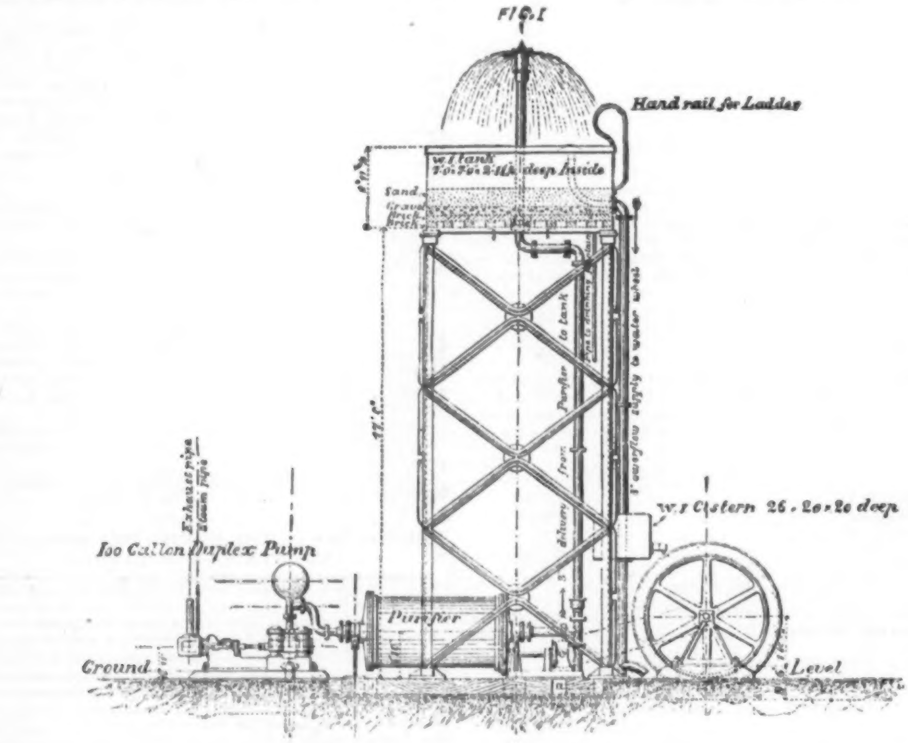
The inlet pipe opens against a disk 1 ft. 5 in. diameter, attached to the end of the cylinder, and within ½ in. of it. This compels the entering water to spread out radially in all directions, and so flow uniformly along. The outlet pipe is fitted with an inverted bell mouth, so proportioned that the speed of the upward current through it is too low to allow any but the very finest iron to be carried up and wasted.

The cylinder is fitted with a manhole and an air cock for letting out the gases, which are sometimes apt to collect, and is driven by a spur ring cast on one of the end covers, actuated by a train of wheelwork, which is brought into motion by a small overshot waterwheel, through the instrumentality of a pitch chain.

The water from the purifier, impregnated with iron, is carried by a 3 in. pipe through the bottom of a wrought iron tank, 7 ft square and 3 ft. deep, which is formed into an ordinary sand filter. The water falls from the delivery pipe some 4 ft., in the form of a thin bell jet, and in that way gets well exposed to the air. It runs through the sand at the rate of 12 cubic feet per twenty-four hours, and as the water is 18 in. deep over the sand, it will remain for three hours before it reaches the latter, thus giving sufficient time for all the iron to become oxidized and precipitated.

The filter is capable of yielding about 2½ gallons of water per minute, the surplus delivered by the pumps, or 97½ gallons, after working the water wheel, by which means it is further aerated, flows into the return culvert leading to the centrifugal pump near the Albert Hall, where it is again lifted to play the cascades. The iron taken up by the water will be deposited in the culvert, which will thus act the part of a sand filter. Three of the Anderson revolvers, capable each of dealing with 1,500 gallons per minute, or together 2,160,000 gallons per day, were set to work in the month of March last at Antwerp, and are now purifying the whole of the water supplied to the city in a most satisfactory manner. The turbid and highly impure waters of the Nethe, quite as offensive as those of the Thames at London Bridge, are rendered perfectly colorless, brilliant, agreeable to the taste, and chemically more pure than any water supplied to London.

The quantity of iron consumed depends upon the quality of the water being treated; it is not likely to exceed one-tenth grain per gallon, or, say, 14 lb. per million gallons. The cost will depend upon the current price of iron, but as borings and turnings form the best material, the expense is, in any case, very insignificant. The power required to drive the machine is also very small, about ½-horse power per million gallons per day.



IMPROVED WATER PURIFYING APPARATUS.

PSYCHOGRAPHY.

The remarkable phenomenon known as psychography is exciting very general attention. The question of its genuineness, and, if genuine, of its nature, is being acrimoniously discussed. One distinguished *savant*, taking unwittingly a leaf out of the book of the Bestiarians, wishes to suppress research in this direction by the blundering arm of the Law. Even the *ultima ratio stultorum*, the formal appeal to Plutus, has been duly invoked. Surely therefore it is time that these alleged facts should be studied in the same calm, cold manner, and with the same indifference as to possible results, as are customary in the announcement of the discovery of a new planet or a new metal.

A word as to my point of view. I am no "Spiritualist." Certain of the doctrines of Spiritualism, as I apprehend them, would be to me highly unwelcome; but to refuse the investigation of novel or unexplained phenomena on such grounds is assuredly unworthy of a man of science. We cannot dispose of truths by the simple process of shutting our eyes and denouncing their discoverers as "skunks."

The facts of so-called "psychography" are simplicity itself, and will need here merely the barest recapitulation. Two persons meet in any ordinary room; one of them, the so-called medium, sits quietly in a chair, generally near a table of ordinary construction. The other person, whom I will call the investigator, takes two clean slates, binds them firmly together with waxed thread, having left between them a fragment of slate-pencil or of red chalk, and lays them on the table. The medium places his hand upon them, and in a short time, supposing the experiment successful, a sound like that of writing is heard. On untying the slates one of their inner surfaces, or sometimes both, is found covered with writing, while the slate-pencil or other material is found worn down as if it had been used.

The features of the experiment have been much modified on different occasions. The slates used are sometimes taken by the observer from a heap kept for the purpose by the medium, and before being used are carefully cleaned by the observer with a sponge and water, and rubbed dry with a cloth. Not unfrequently the observer brings with him a pair of new slates which he has bought on his way to the medium's house. In some cases a double folding-slate has been used, secured by a lock.

The position in which the slates are laid after being secured together has also greatly varied. Sometimes they are laid *on* the table, the medium touching them with one hand. Sometimes the medium holds them against the under surface of the table with one hand, while with the other he holds the hand of the spectator. Again, the spectator has held them upon his own head with one hand, while with the other he clasps that of the medium. Or they may be laid upon the table, and never touched by the medium at all. All these experiments, it is well to remember, are performed in full, open daylight.

The nature of the table used, and of the chair in which the medium sits, is a matter of indifference. Both have been carefully examined without disclosing any mechanism or concealed appliances whatever. Other tables and chairs have also been substituted; but the phenomena are unaffected.

Something must also be said concerning the subject-matter of the writing. Very frequently the observer writes some question upon the slates before closing them up, and receives a definite answer—occasionally touching matters known to no living person but himself, and of which the medium cannot be supposed to have any knowledge. Such answers may even be given in languages with which the medium is unacquainted. Nor must it be forgotten that the observer is sometimes asked, after putting both a bit of pencil and a piece of red chalk between the slates, With which shall the expected writing be produced? And the result comes out accordingly.

It is not, I think, necessary to go more closely into the details of psychographic experiments, since they may be found given with considerable minuteness in various works and journals. But the question is, How are these recorded phenomena to be explained?

The first attempted solution is, if nothing else, remarkable for its sweeping character and for its simplicity. The spectators, we are told, are all conscious and intentional liars. Such an explanation scarcely admits of discussion. To most minds it will be utterly inconceivable that a number of persons, of different ages, nationalities, prepossessions, habits, and thought, should agree in forging a falsehood from which they could reap no manner of advantage. Most minds will conclude that were such the case some one witness, at least, would have come forward to expose the fraud—an exposure which, in not a few quarters, would be exceedingly welcome. How, then, on the hypothesis of falsehood, do Spiritualists contrive to seal the lips of each succeeding spectator?

The next hypothesis is that the spectators, though not intentional deceivers, are self-deceived, and fancy that they see occurrences which never took place. Or they are pronounced to be incompetent, untrained observers. A moment's reflection will show that this supposition cannot hold good. In the first place must be noted the extreme simplicity of the phenomena. There is nothing to excite any passion or emotion; nothing to engage ear and eye, and thus draw off the attention of those present from what is being done, or rather from the manner in which it is effected. There is nothing that requires the trained observer or the scientific specialist. Were it a question turning on delicate spectroscopic or microscopic observations, I should not for a moment accept the evidence of a non-specialist, however highly educated, intelligent, and upright. But this is not the case; any sane man of common sense and fair moral character can decide as well as Professor E. Ray Lankester whether the slates used were clean before being tied together; whether the medium had, or had not, the opportunity of tampering with them; and whether, when untied, they were found covered with written matter. I repeat it that, to my apprehension, the most illustrious man of science would have no advantage in making such observations.

But I may be told that it is all clever jugglery. Jugglers can certainly do very surprising things, and they are in these days a prosperous and influential class, whose honor and reputation the Law appraises at a high figure. But I may at least, without fear of an action for libel, assert that their power has its limits.

No juggler has as yet reproduced the phenomena of "psychography" as above described, and under test conditions. If Maskelyne and Cooke will, like Eglinton, sit down at an ordinary table, and, without apparatus of any kind, produce intelligible writing between two locked slates, which never pass into their hands at all, and which they thus have no opportunity of manipulating, we may then with a show of reason refer this matter to jugglery.

But let us examine this part of the subject a little more closely. How can jugglery be conceived as possibly producing the results described? It may be said that the writing pre-exists on the slates before they are tied together, and becomes visible in consequence of the escape of—a something. This hypothesis is not easily reconciled with the circumstance that, even when the slates are the property of the medium, they are selected by the observer at haphazard from a heap, and are well cleaned and carefully examined by him before being tied together. But it is put completely out of court by the fact that the slates are often brought by the intending observer, and have never even been seen by the medium or by any possible confederate.

The next supposition is that the medium unties or unfastens the slates after they have been fixed together, executes the writing, and fastens them up again as before. We will take the case most favorable for this view—that, namely, where the medium holds the slates against the underside of the table with one hand, his other hand and all the rest of his person being full in the view of those present. Are we to admit that with that one hand he unties the slates, supports them and the strings or tapes, performs the writing, and ties the slates together again? If so, great is our faith. It

may be urged that there are supports beneath the table, by which the slates, string, etc., are upheld while the medium is writing. I reply that the table has been examined, and that no such contrivances are to be found. But how about those cases where the slates lie all the time open to view, upon the table or on the head of the observer, the medium not touching them at all? Such are crucial instances which completely overthrow this unfastening and writing supposition.

I have also heard it insinuated that the slates upon which the writing is found are not the same pair which have been formally prepared, these latter having been dexterously conveyed away and others substituted. This hypothesis is negatived by the cases where the slates remain in view, and are never handled by the medium. It also fails to account for the fact that slates brought by inquirers, and marked privately without the knowledge of the medium, are expressly found not to have been changed.

"The effects are due to electricity or something"—the something being, I will charitably suppose, some other possibly as yet unknown form of energy. That electricity can produce strange effects I shall not question. Nor shall I dispute that there may be forms of energy still more wonderful. But the table and the seat of the medium contain no hidden batteries, no secret conductors. They may, as I have already pointed out, be exchanged for others. They may also be removed to any other part of the room, or to another room—a step by which any physical arrangements would necessarily be frustrated. Nor has any spectator detected the presence of electric or magnetic currents on or near the table.

We may go further; electricity, magnetism, are not intelligences. By their means it is indeed possible to transmit messages, questions, or answers from one place to another, and to reproduce them in speech or in writing; but there must be an intelligence at the other end of the line. It is utterly inconceivable that electricity or any physical force should of itself combine letters into words, and words into intelligible sentences, conveying often a precise and accurate reply to a question put. It is known that an electric commotion passing over a telegraphic system will sometimes set the instruments at work; but the messages thus sent are mere random combinations of letters, which never—save by rare chance—form even a word, and never certainly an intelligible combination of words. Should such a thing ever happen, every experienced telegraph operator would feel sure that some trick had been played, and that the message was not and could not be the outcome of an electric storm.

The writing, it seems to me, must indubitably be produced by some intelligence. But what intelligence? Not by a man; for, in addition to the fact that the crumb of pencil or chalk is generally too small to be grasped by human fingers, we have invariably the testimony that no person has or could have in any way interfered with the slates. Surely we are thus driven from post to pillar until we have but one alternative remaining, the assumption that there must exist around us intelligences invisible and capable of interfering with the course of events, with what we are accustomed to call the order of nature. What these intelligences are, what is the extent of their power, and under what conditions it is exerted, I am utterly ignorant. They may be, as the Spiritualists hold, the "spirits" of departed human beings; or they may be the "spooks" or "shells" of the Theosophists, the "elemental spirits" of the Rosicrucians, or the fiends and familiars of mediæval sorcery. To which of these classes the agents in question belong is still an unsolved problem. The Spiritualists allege that the minute acquaintance which these intelligences show with family secrets, with private conversations formerly held between the investigator and the deceased friend, prove their identity with such friends. But it is replied by other persons, believers all the same in the reality of psychography and of kindred phenomena, that if we are surrounded by invisible intelligences, they may know our past careers, our actions, our words, perhaps even our thoughts, and may thus easily assume the part of some friend whom we have lost. It is even conceivable that these invisible intelligences may not be spirits at all, but strictly material beings, capable of acting in 4 or 5 dimensional space, as expounded in the last issue of the *Journal of Science*, and which under all ordinary circumstances escape our perceptions.

Hence it seems to me premature to pronounce these and similar manifestations a refutation of Materialism. It is probably still more premature to infer from such phenomena the continued existence of man after what is ordinarily called death. On these points psychography does not appear to give any definitive assurance.

But the conclusion seems to me unavoidable that if unseen beings, be they spiritual or material, whatever these terms may mean, can interfere with the cause of nature, we have no longer any assurance that like causes will be followed by like effects.

To give an instance; every man who knows that fuel has been laid in a stove, and who some hours afterward finds it blazing, will conclude—perhaps I must say "would have concluded" until lately—that some human being had set it on fire. Yet we find it recorded in "Light" that a certain family were regularly accustomed, on rising in the morning, to find their kitchen fire had been kindled by some invisible being. Now, if "spirits," or 4 dimensional beings, can thus interfere, what confidence can we have in the results which we obtain in our chemical and physical laboratories? In fact, it is hard to say what basis remains on which science can be built.

I read, in a recent article in the *Journal of Science*, how an eminent chemist points out the necessity of performing toxicological investigations in a laboratory to which no one but the operator can have access, lest some interference, intentional or accidental, might take place. But if invisible agencies can interfere, how are they to be excluded?

Bearing in mind these considerations, Spiritualists might well speak in a milder tone of reluctance of scientific men to accept their results. Of course an unpleasant truth is not the less true if we close our eyes to its evidences and to its existence. But what if the activity of the last forty years has made possible what before was impossible? How if the little "tap, tap" of spiritualism has not merely "shattered the marble image of materialism," but broken down a partition wall which barred out invisible agencies from interference in our world? In that case it strikes me that the refutation of materialism has cost us far too dear.—*R. M. N., Jour. of Science.*

ON THE ORGANIZATION OF THE TRIBE.*

By J. W. POWELL.

So far as is now known, tribal society is everywhere based on kinship. In the simplest form of which there is any knowledge, the tribe consists of a group of men calling one another brother, who are husbands to a group of women calling one another sister. The children of these communal parents call all of the men fathers, and all of the women mothers, and one another brother and sister. In time these children become husbands and wives in common, like their parents. Thus the kinship system recognizes husbands and wives, fathers and mothers, sons and daughters, brothers and sisters, and grandparents and grandchildren. The only kinship by affinity is that of husband and wife. The only collateral kinships are those of brother and brother, sister and sister, and brother and sister. The lineal kinships are father and son, father and daughter, mother and son, mother and daughter, with grandparents and grandchildren also recognized. There is no recognized father-in-law, mother-in-law, brother-in-law, nor sister-in-law; there is no uncle, no aunt, no cousin, recognized.

It will thus be seen that all of the collateral kinships of uncle and aunt and nephew and niece are included in the lineal kinship of parent and child, and cousins of whatever degree are reckoned as brothers and sisters. Let any person be designated as *Ego*. Then all the men of the antecedent generation are his "fathers," and all the women his "mothers;" all the males of his own generation are his "brothers," and all the females his "sisters;" and all the males of the following generation are his "sons," and all the females his "daughters." Selecting the Ego from any generation, and reckoning from him the antecedent and subsequent generations, the following consanguineal kinship groups will be found: Ego will be one of a group of brothers; there will be a group of sisters, a group of fathers, a group of mothers, a group of grandfathers, and a group of grandmothers; there may also be a group of sons and a group of daughters, a group of grandsons and a group of granddaughters.

In the use of the terms "brother," "sister," "father," "son," "mother," "daughter," "grandfather," "grandson," "grandmother," and "granddaughter" in this manner, it must be clearly understood that in every case the term applies to every one of the members of a group, only a part of whom bear the relation which that term implies among civilized peoples, who classify by *degrees* of consanguinity.

Thus, the father-group embraces the father and all his own brothers; but as the father calls all his male cousins brothers, it also includes the father's male cousins. The father-group therefore includes the father and all of those persons whom the father calls by the name of "brother."

Ego calls all the sons of his father and mother brothers; he calls also all his father's brothers' sons, and his father's sisters' sons, and his mother's brothers' sons, and his mother's sisters' sons, brothers. And if there be male cousins of the second, third, fourth, fifth, or any other degree, he calls them all alike brothers. The brother-group, therefore, may be very large. In like manner the mother-group, the sister-group, the son-group, and the daughter-group may be correspondingly large. The grandfather-group and the grandmother-group include all collateral kindred of that generation; and in like manner the grandson-group and the granddaughter-group include all the collateral kindred of their generation. Under this system all kinships may be thrown into a very few groups, and each one of these groups is designated by the kinship term properly belonging to the person in the group nearest of kin to Ego.

The essential principle of this method of reckoning kinship is that collateral kinship is not recognized. All of the kindred are included in the lineal groups; and in every generation a group of brothers is constituted, including all of the males of that generation, and a group of sisters is constituted, including all of the females of that generation.

That such a kinship body has ever existed is a matter of inference; its discovery as an objective fact has not been made. However, it is predicated upon very strong inferential evidence. In the forms of society actually found among the lower tribes of mankind, institutions are discovered that are believed to be survivals from such a form of tribal organization. And the philologic evidence is perhaps still stronger; in fact, the hypothesis was originally based solely upon linguistic data, as languages have been found in which terms for husband, wife, father, mother, son, daughter, elder brother, younger brother, elder sister, and younger sister occur, together with those expressive of the kinships that arise through the recognition of grandparents and grandchildren, while terms for collateral kinships are not found.

All tribes that have yet been carefully studied present a more elaborate form of social organization than that above described. This more highly developed structure is usually exhibited, among other things, in a more elaborate system of classifying kinships. Additional groups are constituted, so that certain collateral kinships are differentiated.

In the brothers and sisters of parents four natural kinships are possible, namely, (*a*) paternal uncle, called by the Romans *patruus;* (*b*) maternal uncle, called by the Romans *avunculus;* (*c*) paternal aunt, called by the Romans *amita;* and (*d*) maternal aunt, called by the Romans *matertera*. The recognition of these four groups would lead to the recognition of the correlative cousins, in four classes, male and female in each class; and if terms were used distinguishing sex, eight classes of cousins would arise through the four classes of uncles and aunts. In this manner the first step in the differentiation of additional kinships is made. Let us call paternal uncles *patruates*, maternal uncles *avunculates*, paternal aunts *amitates*, and maternal aunts *materterates*.

Let us suppose that the relation of husband and wife is not the same as the relation of brother and sister; that is, that men do not marry their own sisters, but that a brother-group still marries a sister-group in common. In this case, fathers' sisters will no longer be mothers, but will constitute a group of amitates. In like manner, mothers' brothers will no longer be fathers, but will constitute a group of avunculates. The institution of a group of amitates will necessitate the establishment of the correlative cousin-groups. Thus, with the reduction of the father-group there will be a corresponding reduction of the brother and sister groups; and with the reduction of the mother-group there will be an additional corresponding reduction of the brother and sister groups; that is, the paternal aunts and maternal uncles will carry with them their correlative nephews and nieces, and such nephews and nieces will be subtracted from the brothers and sisters. In this stage of kinship development there is still communal marriage. It may not always be actual, as gradually restrictions are thrown around it; but if not actual, it is always potential. The form of kinship now reached is not in inference from philology and the survival of customs, but is an observed fact among some of the tribes of the earth.

The recognition of patruates (paternal uncles) must next be considered. Such a recognition results in the establishment of two additional cousin-groups, as the sons and daughters of patruates are taken out from the "brothers" and "sisters" of Ego. At this stage, brothers and sisters are still own (natal) and collateral, but the collateral brothers and sisters include only the children of mothers' sisters, and this because a group of materterates is not established.

We have now reached that kinship system which is perhaps the most widely distributed among existing tribes of mankind. It will be well, then, to describe it once more, that it may be clearly understood.

The brother-group consists of the sons of a woman, together with the sons of all of her sisters, own and collateral; and the sister-group is of like extension. The son-group is coextensive with the brother-group to which the son belongs; the daughter-group is coextensive with the sister-group to which the daughter belongs; the father-group is coextensive with the brother-group to which the father belongs; and the mother-group has a like extension. The patruate-group is coextensive with the brother-group of the paternal uncle; the amitate-group is coextensive with the sister-group to which the paternal aunt belongs; the avunculate group is coextensive with the brother-group to which the maternal uncle belongs; but there is no materterate-group (maternal aunt).

The essential characteristic of this system of kinship is that the brother-group consists of own brothers, together with the collateral brothers that come through maternal aunts; and that the sister-group consists of own sisters, together with the collateral sisters that come through maternal aunts; and it matters not whether maternal uncles and paternal uncles are distinguished from each other. They may or may not be thrown into one group. The cousins which arise from the discrimination of paternal and maternal uncles and paternal aunts may be thrown into two, four, or six groups; but the general system does not seem to be affected thereby. Where this system of kinship prevails, the brother and sister groups are on the mother's side, the children belonging to their mothers and not to their fathers; and descent is said to be in the female line.

There is another system of tribal organization which widely prevails. In this the mother's sisters are recognized as maternal aunts, and a materterate group is constituted of the mother's sisters, own and collateral; and the cousins arising therefrom are taken out from the brother and sister groups. But in this case the father's brothers, own and collateral, are still considered as fathers; there is no patruate-group. The brother-group is thus composed of the sons of the father with the sons of all his brothers, own and collateral. It is therefore a large group; and the sister-group corresponds therewith. When the brother and sister groups arise through paternal uncles, children belong to their fathers, and descent is said to be in the male line.

From the above statements it will be seen that one of the fundamental principles used in classifying kinships in tribal society is that which arises from the discrimination of generations. The simple communal form first described is classed in groups of kindred on characteristics of generations and sex, and in the various systems which develop from it the characteristic of distinct generations still remains, although collateral descents are to some extent differentiated from lineal descent.

It would seem that generation-groups extending collaterally many degrees would speedily become confused, as a series of generations might be much shorter in one line than in another. If three sisters have each three daughters, the eldest daughter of the eldest sister may be many years older than the youngest daughter of the youngest sister, and in several generations the discrepancy of ages might became very great. We do not know in all cases how this confusion is avoided, but in some tribes a method of adjustment has been discovered which is very simple.

It must always be remembered that relative age is expressed in the kinship terms of this stage of culture. Thus there are two terms for brother, one signifying elder brother, the other younger brother. There are also two terms for sister—elder sister and younger sister. In the Shoshonian cases to which reference is here made, if a male child is born who is a "group" brother of Ego's father, but younger than Ego, Ego does not call him father, but younger brother. In one case discovered Ego calls the "group" father born after himself, son. Among the same tribes, in the case of uncles, the uncle born after the nephew is called nephew.

A case like the following has been discovered: There are two brothers born of the same mother; the elder brother calls a particular person son, because that particular person was born after himself; but the younger calls him father, because he was born prior to himself. This method of adjusting generations has been discovered in but few cases, viz., among the Shoshonian tribes, and perhaps among the Wintuns. In this stage, language frequently lends its aid to adjustment. This is the case when the kinship name is a reciprocal term with a termination signifying elder or younger. Thus, in a Shoshonian tribe *ain* is such a reciprocal term used by uncle and nephew; the termination *sen* is a diminutive. The nephew calls his uncle *ain*, the uncle calls the nephew *ainsen* or *aitsen*, little uncle; and in this case, if the uncle was born after the nephew, the nephew would

* Read before the National Academy of Sciences, April 22, 1885.

be called *ain* and the uncle *aitsen*. A reciprocal relationship term is one designating relationship, and used by both parties.

In some of the cases adjustments are known to have been made by convention, and individuals have been taken from one generation and placed in another, by agreement of the elder women of the clan.

Unadjusted kinships are frequently discovered, so that kinships claimed by both parties seem strange to civilized persons accustomed only to kinships recognized in the higher states of culture. Thus, it has frequently been found that an adult has claimed a child for his grandmother and a babe for his father. The subject is one of interest, and deserves careful study.

The method of classifying and naming by kinship terms the six groups of cousins, their children, and their children's children, has been neglected, in order that the general subject might not be buried in details, and from the further consideration that the principles of tribal organization can be set forth without the aid of such additional facts.

In the above statements the fundamental principles of tribal kinship have been explained, and they may be restated as follows:

I.—A body of kindred constituting a distinct body politic is divided into groups, the males into groups of brothers, and the females into groups of sisters, on distinctions of generations, regardless of degree of consanguinity; and the kinship terms used express relative age. In civilized society, kinships are classified on distinctions of sex, distinctions of generations, and distinctions arising from degrees of consanguinity.

II.—When descent is in the female line, the brother-group consists of natal brothers, together with all materterate male cousins of whatever degree. Thus mothers' sisters' sons, and mothers' mothers' sisters' daughters' sons, etc., are included in a group with natal brothers. In like manner, the sister-group is composed of natal sisters, together with all materterate female cousins of whatever degree.

III.—When descent is in the male line, the brother-group is composed of natal brothers together with all patruate male cousins of whatever degree, and the sister-group is composed of natal sisters, together with all patruate female cousins of whatever degree.

IV.—The son of a member of a brother-group calls each one of the group, father; the father of a member of a brother-group calls each one of the group, son.

Thus a father-group is coextensive with the brother-group to which the father belongs. A brother-group may also constitute a father-group and grandfather-group, a son-group and a grandson-group. It may also be a patruate-group and an avunculate-group. It may also be a patruate cousin-group and an avunculate cousin-group; and in general, every member of a brother-group has the same consanguineal relation to persons outside of the group as that of every other member.

The principles enunciated above may be stated in another way, namely: A kinship body is divided into brother-groups and sister-groups, and group is related to group lineally and collaterally; and every group bears a distinct relationship to every other group.

It will thus be seen that the brother-group and the sister-group constitute the fundamental units of tribal society.

A tribe may be defined as follows: A tribe is a congeries of brother-groups and sister-groups, and every group recognizes a distinct correlative consanguineal kinship with every other group; and series of groups are related to series of groups by the ties of affinity, *i. e.*, marriage; to explain which necessitates the consideration of the clan.

In tribal society, the tribe, or body politic, is divided into groups of brothers and groups of sisters. One form of the brother-group includes not only the sons of one woman, but also the sons of her sisters; and not only the sons of her natal sisters, but also the sons of her collateral sisters, *i. e.*, the brother-group includes the natal brothers, together with all of the male cousins of the first, second, or *n*th collateral line, reckoning always through females. Sister-groups are constituted in like manner.

Another form exists in which to the natal brothers are added all male cousins to the *n*th degree that come through paternal uncles, reckoning always through males. Sister-groups are constituted in like manner.

With some tribes the brother and sister groups arise from male descent; but a much larger number of tribes have these groups constituted through female descent. The two systems of kinship are at the base of two distinct systems of clan organization.

When the brother and sister groups arise through female descent, a larger group is constituted, reckoning kinship through females only. The constitution of this larger body, a group of groups, must be clearly understood. Every brother-group has its correlative sister-group. Take, then, a brother-group and a sister-group that are thus correlated, and call them the *Ego* group. The mothers of the Ego group constitute another sister-group within themselves, and the brother-group to which they are correlated are the avunculates of the Ego group. Call this brother and sister group the first ascendant of the Ego group. The mothers of the first ascendant group constitute another sister-group within themselves, and the brother-group to which they are correlated are the avunculates of the first ascendant group. Thus a second ascendant brother and sister group is constituted. In the same manner third, fourth, and *n*th ascendant brother and sister groups may be constituted.

Returning now to the Ego group. The sisters of the Ego group have sons and daughters who are brothers and sisters to one another, and they constitute a first descendant brother and sister group. The sisters of the first descendant group have children who are brothers and sisters to one another, and constitute a second descendant group. In the same manner the third, fourth, and *n*th descendant groups may be constituted. The Ego group, together with the ascendant groups and descendant groups, constitute a lineal series of brother and sister groups, reckoning always through females. Such a body is here called a group of *enates*, and kinship thus reckoned is called enatic kinship. On the other hand, if the brother and sister groups come through paternal uncles, and the lineal series is reckoned exclusively through males, it is called a body of *agnates*, and the kinship agnatic kinship.

Whenever enatic or agnatic kinship is recognized, the tribe becomes much more highly composite than in the case of the communal family. There are always several co-ordinate groups of people united into a larger group, the tribe. For the present let us use the term "tribe" for the name to distinguish the group of the highest order, and the term clan to distinguish each of the co-ordinate groups of the second order into which the tribe is divided.

The first characteristic of the clan is thus reached: A clan is one of the co-ordinate groups into which a tribal state is divided.

The tribe itself is a body of intermarrying cognates; so that, in the tribe, kinship by consanguinity and affinity is recognized. Within the clan, kinship by affinity is not recognized, that is, the husband and wife do not belong to the same clan, and kinship by consanguinity is limited to kinship traced through females, or to kinship traced through males, as the case may be; and in both, but a part of the cognates are included. In one case the clan is enatic, and in the other it is agnatic. In the one case descent is through females, in the other through males. An enatic clan consists of a brother-group and a sister-group in each of the generations represented in the clan, and the kinship is reckoned only through females. An agnatic clan consists of a brother-group and a sister-group in each of the generations represented in the clan, and the kinship is reckoned only through males.

A second characteristic of a clan may therefore be given: A clan is either a body of enatic or agnatic kindred.

When the clan is enatic, it usually has a common worship of a tutelar god. This must be distinguished from the tribal worship, which is more miscellaneous, and based upon polytheism. The tutelar god, or totem, is often an animal; or sometimes it may be a river, a mountain, the sun, or some other object; in which case the members of the clan call themselves the children of the animal, the river, the mountain, or the sun, as the case may be. When the clan is agnatic, the tutelar god is usually some ancestor who has distinguished himself for valor or wisdom.

A third characteristic of a clan is thus reached: A clan is a body of kindred having a tutelar god, totemic or ancestral, who is considered to be the father of the clan.

When the clan is totemic, it usually takes the name of its tutelar god as its name, and the picture-writing, or symbol, of the tutelar god is used as a badge to distinguish the clan. That the members of a clan have descended from a common parent seems at present to be usually a legal fiction. In tribal society age is greatly revered, and "elder-rule" largely prevails; so the gods are spoken of as "fathers," or more usually "grandfathers," or even "ancient fathers," and sometimes simply as "ancients," that is, "the venerable." But the tutelar god is especially the guide and protector of the clan, and is therefore called "father," and it seems that in many cases a myth is developed, explaining this fatherhood as being real. When the tutelar god is a real ancestor (and such seems to be the case when the clan is agnatic) the clan takes the name of the ancestor.

A fourth characteristic of a clan is therefore reached: A clan is a body of kindred having a common name, the name of its tutelar deity.

The clan, whether enatic or agnatic, is composed of brothers and sisters in each generation; and in the custom law of this stage of culture, brothers and sisters cannot intermarry. In like manner, when the clan is enatic, by the same custom law a mother cannot marry her son, natal or fictitious; and when the clan is agnatic, a father cannot marry his daughter, natal or fictitious. Thus it is that marriage within the enatic or agnatic group is incest, and is usually punished with death. The rules for marriage outside of the clan are various, and the subject need not here be entered upon. It is sufficient to note that the group is exogamous. It will be seen that the term "exogamy" is here used in a sense altogether different from that given it by McLennan and the writers of his school.

The fifth characteristic of a clan, therefore, is reached: A clan is a group of exogamous kindred.

As a clan is a brother-group and a sister-group in each generation, though these ties are in small part real, and in large part artificial, yet they are considered to be the closest, and to combine the group into the firmest union. The body therefore constitutes a feud-group to secure one another's rights and to avenge one another's wrongs. The clan is held responsible by the tribe for the conduct of its members. All controversies arising within the clan are settled by the clan; all controversies arising between members of different clans are settled by the tribe. For personal injury, especially for maiming and murdering, every clan holds every other clan responsible. Out of this arises the blood-feud, and out of blood-feud arises outlawry; for when a clan finds that one of its members has become so outrageous in his conduct that the other members no longer wish to hold themselves responsible therefor, the clan formally declares that the culprit no longer constitutes one of the community. The offender is expelled from the clan and becomes an outlaw, and any one may kill him.

A sixth characteristic of a clan has been reached: A clan is a feud-group of kindred.

In tribal society great wealth is not accumulated. The indirect personal relations which arise through property are of minor importance as compared with direct personal relations, which are regulated by kinship and relative age. The institution of personal property is very slightly developed, and such property, especially in the lower forms of tribal society, is destroyed at the death of the individual. It is a widely spread law in savage society that personal property is inherited by the grave. The tenure to the greater part of property is communal, and inheres in the clan.

A seventh characteristic of a clan has therefore been reached: The clan is the chief property-holding group.

It has already been mentioned that elder-right, in some form or other, is universally recognized in tribal society. In general, *cæteris paribus*, the elder has authority over the younger, and in all tribal languages a special device is found to facilitate this custom, viz., individuals must always address each other by kinship terms in which relative age is expressed; thus, there is no general term for "brother," but a special term for "elder brother," and another for "younger brother." This elder-rule applies to the clan, as the eldest man of the clan is its chief, and such a chief, whose rulership is by right of superior age, will here be called the *presbyarch*.

An eighth characteristic of a clan has therefore been reached: A clan is a presbyarchy.

Let these characteristics be combined into a definition: A clan is one of the co-ordinate groups into which a tribe of cognate people is divided, and is based upon enation or agnation, has a totemic or ancestral tutelar god, a common name for its members, is exogamous, is a feud-group, a proprietary group, and is ruled by a presbyarch.

There are many other characteristics of a clan that are found, now here, now there. For example, sometimes a clan will not eat the animal, or some portion of the animal, whose name it bears; it will thus have what is usually called a "taboo." Sometimes the several clans of a tribe will claim, as their own, particular hunting or fishing grounds. Sometimes a clan will have a body of personal names to be given to its members, which the clan claims as its own. Often a clan has a particular place assigned to it as the site for its residence or residences in the village group, and will occupy the same relative place in the village wherever the tribe may have a permanent or temporary residence. Thus, there are many rights and duties which inhere in a clan, and which may be said to characterize it. But the eight characteristics included in the above definition are those most commonly found. In the definition of the clan thus given, the tribe has been assumed to be of very simple structure—as composed of a number of co-ordinate clans. But this simple structure is not universal, in fact a more complex structure is more common. Whenever a tribe has a more complex structure, the characteristics above enumerated may not all inhere in every one of a number of co-ordinate groups, but may be distributed among groups of different orders. It occasionally happens, also, that some of these characteristics are not found in any group. Some of these cases must next be considered.

Let one of the most frequent cases be taken first. Suppose that a tribe, becoming very large, divides in such a manner that segments from every one of the clans separate from the parent tribe and organize a new tribe with the same clans. Thus the clans found in the parent tribe are represented in the new tribe. Suppose that this fissiparous generation of tribes continues until there are five, ten, or twenty tribes, every one having the same clans as every other. Under such circumstances the same clan extends through many tribes, and any one tribe has in its body politic no more than a segment of any clan; but every tribe is composed of like segments. Now, such a uniform division of tribes is rarely found. The division is usually more irregular, from the fact that the departing body which is organized into a new tribe usually takes with it segments of only a part of the clans; and as these divisions occur from time to time, no two tribes are likely to have representatives of exactly the same clans, and it may sometimes happen that two tribes may be found in the same body of cognate tribes that will have entirely diverse clans. The segmentation of clans in this manner complicates the definition of a clan. It is no longer one of the co-ordinate groups of a tribe. These co-ordinate groups are but segments of clans, and each such segment is likely to become a distinct feud-group and a distinct proprietary group. Sometimes in such a case all the segments will yet recognize one presbyarch, but oftener a distinct presbyarch for each segment is developed. Enatic or agnatic distinctions, the common tutelar god, the common name, and the characteristic of exogamy are more likely to remain permanent.

This fissiparous generation of tribes leads to a complication in the definition of the term "tribe," as such cognate tribes are likely to unite into confederacies, with a council and a chief presiding over the larger body thus constituted; and in the various changes which may be wrought upon the different groups of several orders in a confederacy by many redistributions of characteristics, it sometimes becomes difficult to say just what order of groups shall be called tribes. Confederacies also form alliances, and though they are apt to leave the confederacies or tribes of which they are composed independent and autonomous, except for offensive or defensive purposes against more foreign peoples, they doubtless sometimes continue, and become more thoroughly cemented by the development of kinship ties and governmental organizations.

Sometimes clans divide into sub-clans, while yet remaining in the same tribe. The nature of this division in enatic clans is not clearly understood. It may be that it does not occur normally, but that the apparent instances are due to the recoalescing of tribes. Be this as it may, it occurs with agnatic clans. Agnatic clans may be ruled by a presbyarch, and may be divided into segments, each one of which is ruled by a patriarch, the patriarchies being subordinate groups within a presbyarchal agnatic clan. Under these circumstances, however, the authority of the presbyarch is likely to wane, and the patriarchies are likely to be more enduring, and so the clan is divided into sub-clans. Thus it happens that the presbyarchy is not always a characteristic of a clan.

Again, the members of agnatic clans do not always take a common name. This has been found true of most of the Shoshonian tribes of North America, of the Wintuns, and of other peoples in the western portion of the United States. Whether a common name was never used, or whether such common names have been lost in the flux of time, is uncertain. A common name, therefore, is not an invariable characteristic of a clan.

The most enduring characteristics of a clan, therefore, are these: Enatic or agnatic kinship, exogamy, and feud-protection. But even these may be distributed among different groups; so that the ideal definition of a clan above given will apply in all its parts to but few clans; yet in most of its parts it will apply to nearly all clans. But there are cases when these characteristics are so distributed through the various groups of a body politic that it will be well-nigh impossible to decide which should be called the clan. Under such circumstances it perhaps will be best to apply the term "clan" to the group based upon enation or agnation, as the case may be, and perhaps it will always be found that such a group is exogamous.

Exogamy is a derivative institution; its antecedent is marriage by legal appointment within a prescribed group. Thus, when there are many co-ordinate clans within a body politic, a man must marry within some other particular clan. By various processes the right

to marry within other clans is obtained, until at last a man may marry within any but his own. Marriage by prescription falls, but marriage within the enatic or agnatic group to which he belongs is still considered incest. Until, therefore, the right of marriage extends to all clans but that of the individual himself, exogamy is not fully established.

The primitive institution is marriage by prescription or legal appointment; this develops into marriage by personal choice. But there remains as a survival from the primitive institution a prohibition which may be called exogamy, the violation of which is a crime called incest.

In Australia there seems to be another complication. Fison and Howitt describe a very peculiar condition of affairs which seems to extend through many of the tribes of that great island. Among them, marriage within a prescribed group still remains. Enatic kinship, a tutelar god, and a common name still attach to the clan, but clans are divided into many segments constituting the different tribes. It seems also that a limited marriage, or the right to temporary sexual association, is still communal. It seems further that two or more systems of tribes are in somewhat the same stage of institutional culture. These different systems of tribes appear not to be cognate, or, if cognate, they are very remotely so. But having been long associated, and having common institutions in the respects above named, the clans in the different non-cognate tribes have become assimilated, so that a clan with a totemic name in one group of tribes has come to be considered as the equivalent of another clan having another totemic name in another group not cognate to the first; that is, the clan of one group is supposed to be equivalent to the clan of another group, and temporary marriage rights extend across the lines which demarcate non-cognate groups.

Some of the Australian tribes present another interesting variation. It must be understood that a clan is composed of a lineal series of brother-groups, one for each generation, together with a lineal series of sister-groups, one for each generation. In the case under consideration the series of brother-groups is distinguished from the series of sister-groups by a different name. Thus the clan is divided, the males from the females, and the enatic kindred are separated into two groups, the daughters falling into the group of their mothers, and the sons falling into the group of their mothers' brothers.

Still other tribes in Australia have a clan system in which the brother-group of one generation is distinguished from the brother-group of the next generation by a different name, but the brother-group of the third generation takes the name of the brother-group of the first generation. The same change of names occurs in the series of sister-groups. The grandmother belongs to a group having the same name as the granddaughter.

The typical tribe which has been described is a body of kindred divided into brother and sister groups, every group having some kinship with every other group. Marriage is without the clan but within the tribe, therefore a man cannot marry into his own sister-group, but must marry into some cousin-group. To the consanguineal tie an affinital tie is added. A male cousin becomes the husband, and a female cousin becomes the wife. In many cases the brother-group of the husband becomes a husband-group, and the sister-group of the wife becomes a wife-group. The brother-group of the husband is related to all the other groups of the tribe, and the sister-group of the wife is also related to all the other groups of the tribe. It is interesting to study the effect which marriage (real or potential) has in changing the consanguineal kinships into affinital kinships. Among the tribes of North America there is much diversity in this respect, but the subject is too much burdened with details to be considered here.

Tribal society is of great antiquity; and in the vicissitudes of tribal life kinship society has undergone many changes, though these changes are restricted to narrow limits. Yet within these limits the changes are very many, and the subject is thereby greatly complicated, and cannot be understood without long and careful research. Passing travelers can no more set forth the institutions of tribal society than they can give a proper description of the flora of a country, the fauna of a region, or the geologic structure of a continent.

A COLOSSAL COTTON TREE.

OUR engraving is from a photograph, and shows the great cotton tree growing in the island of Jamaica.

THE COLOSSAL COTTON WOOD TREE OF JAMAICA.

THE WAYS OF MONKEYS.

By Dr. ALFRED E. BREHM.

SHEIK KEMAL EDIN DEMIRI, who died about A. D. 1405, and was the author of a voluminous treatise on the life of animals, relates the following story as a fact: "The inhabitants of a town called Olila, on the shore of the Red Sea, were in olden times metamorphosed into monkeys, in punishment for their wickedness. They had broken the Sabbath by fishing. Some of their pious fellow-citizens endeavored in vain to convey them back into the path of virtue; and, finally, when all admonitions proved useless, left the town. Returning to their homes three days later, they found, instead of their neighbors, baboons, which met them looking sorrowfully, and expressing by signs and attitude that they recognized the friends whose advice they had scorned with so dreadful a result. In his anger, Allah had inflicted a terrible sentence upon them." The writer carefully insists on the circumstance that the culprits were Jews.

The Prophet and his followers admit this metamorphosis by God's special intervention as a fact, and this fully explains the prominent part assigned to apes in all Arabic fables and tales. The early Egyptians believed religiously that some groups of monkeys were experts in writing, and, by that fact alone, equal if not superior to mankind in general. A number of apes were consequently sheltered and fed in the temples, worshiped during life, and embalmed after death. Those privileged specimens of the four-handed tribe, when first introduced into the temple, were handed a slate and pencil by the chief-priest, and humbly requested to show their right to admission into the sacred asylum by writing. The gamboling and grinning candidates wrote, and nobody ever doubted that the figures traced by their agile hands fully deserved to be classed in the category of hieroglypha. So highly were they held in respect and veneration, that the holy Sphinx was represented with their hair-dress, and, till to-day, men and women in the country of the Mahdi gave their hair the same shape. But the Egyptians never admitted that the priests or Pharaohs were the descendants of monkeys, while, on the contrary, the Hindoos built houses and temples to shelter and worship apes, and venerated the princes of their country as the direct offspring of the holy animals. The Arabs regard the latter as "the descendants of the wicked, to whom nothing is sacred, nothing respectable, nothing too good or too bad; who never feel friendly dispositions for other creatures of the Lord, and are damned by Allah, and carry the likeness of the devil and of man combined on their ill-shaped bodies."

We, the sons of civilization, agree up to a certain point with the Arabs. We also—at least that portion of modern society who have not been given an education or an overtraining in physical science—decline to see in apes anything more than caricatures of ourselves, and repudiate with much aversion the inferences drawn from Darwin's theory. On the other side, highly educated men all over the world have opened the discussion of the relationship between man and monkey, and speaking about the latter nowadays has become a dangerous task, in so far as there is but one alternative left—to offend the ancestry or the offspring! For my own part, I feel no hesitation in approaching the question of relationship to examine its value and in trying to illustrate the life of that pretended cousin of ours.

The apes have established their homes in every continent, Australia excepted. Warmth seems to be one of the principal conditions of their existence, as they are only found in the warmer regions. In America they are spread from 26° south of Mexico; in Asia, from the Sunda Islands to the Japanese Sea. In Europe there exists but one species of monkeys, and its members live all together in one troop on the rocks of the fort of Gibraltar, under the special care and protection of the garrison. That troop numbered in all twenty three individuals when I visited Gibraltar in 1884.

The principal thing the monkeys claim from a country whose clime they are enjoying otherwise is food, plenty of varied food; and this fact fully explains the predilection they have always shown for places where pious superstition provides for their wants and makes their life comfortable.

Among other mammifers the female element wields the scepter in family life, but in the realm of apes the male is invested with the sovereign power, not by general suffrage, but by the right of force. The oldest and strongest male of a troop proclaims himself chief and leader, after having vanquished all his competitors, viz., the rest of the senior males. The longest teeth and

the strongest arms decide in the question of supremacy. All those who show some reluctance to submit are chastised till they come to political reason. To the strongest belongs the crown; in his sharp teeth resides his wisdom.

This ferocious tyrant understands his duty as a leader, and performs the same with dignity. His subordinates flatter and fondle him in every way; the ladies of his harem rival in keeping his dress clean from annoying parasites. As a genuine pasha he accepts this respect with a kind of languid acquiescence. In return, he watches carefully over his vassals, and shows a continual anxiety for their welfare and security. He orders and directs minute details in daily life, and subdues all opposition—for there exists a Left also in the monkey state—by striking and sharp bodily argumentation.

As a general rule, the monkeys go early to bed, rise late, and establish their night encampment on the summit of rocks, if possible. The first thing they do in the morning is to warm themselves, for which purpose they climb to the tops of rocks and trees and turn slowly around in the sun till their hair, wetted by the nightly dew, is entirely dry. This preliminary operation is followed by a thorough cleansing of the skin, and immediately after by breakfast. Every eatable thing suits monkeys—fruits, onions, roots, seeds, nuts, leaves, insects, eggs, young birds, snails—and they enjoy generally a copious, free board. Their notions concerning property are very defective. "We plant and the apes harvest," says the Arab of Eastern Soudan, with his natural apathy in the presence of facts and events that he cannot prevent. Does not the monkey show in this a pronounced analogy with mankind, who since the existence of the world, though under severe penal legislation, find it so hard a task to observe the difference between mine and thine?

The hungry crowd of quadrumana infest fields and gardens; neither lock nor bolt, neither fence nor wall, is an obstacle for those robbers, who steal and destroy everything in their way, whether it be eatable or not. It is not suprising, to any one who has witnessed such depredations, to see the farmers entertain a mortal hatred against these dark, grinning thieves; and the Arabs range them in the category of evil spirits. When they are surprised in their mischievous work, they flee like cowards toward the nearest trees or rocks, the mothers carrying their children. Only when flight is impossible do they show fight, and attack men as well as the biggest beasts of prey, and even elephants, with that impetuous temerity which distinguishes the coward in despair.

After a gestation of from seven to nine months, the female monkey gives birth to one young one, very seldom to twins. The new-born monkey is a little ugly creature, bare of hairs, with spindling limbs and a repulsive, senile face. But the mother is passionately fond of her monster, and caresses and nurses it with remarkable devotion. She does not leave it for a single moment, she presses it to her heart, rocks it to and fro, and takes the utmost care to keep it absolutely clean. In the first period of life the baby is apathetic and almost insensible, but begins gradually to play with urchins of its age. The mother is a patient observer of the first steps of her beloved, and watches carefully that no harm may befall it. In the mean time, she trains it; and the first virtue inculcated in the mind of the youngster is obedience, obedience in the strictest sense of the word. Men have ridiculed the maternal affection of the brute, and speak of "apish love." In our eyes the tenderness exhibited by the monkey may have a ridiculous side, but where is the man who could, without deep emotion, witness the anxiety of a mother ape nursing her sick child? I must confess that, to my eye, in such cases she is at least the equal of the human mother. If the young ape dies, the spectacle is a piteous one. The mother cannot be separated from the dead body, refuses all food, and frequently perishes from grief. In such crises the ape proves certainly his congeniality with the human race, and in his moral affections could stand as an example to many men.

The intellectual cultivation of which the monkeys are susceptible neither raises them so high above the average of mammifers, nor places them so far beneath the level of mankind, as some people contend. Further on, we find in no order of animals, as far as intellect is concerned, so wide a difference between the highest and the lowest individuals as among the monkeys, while, in inverse proportion, the lowest gifted human creature hardly differs from the apes whose intelligence is most developed. In many instances the mental and bodily likeness to humanity is so pronounced that the observer feels quite uncomfortable in presence of the evidently small chasm existing between man and beast.

After this general characterization of the whole species, I may be allowed to trace in large outlines the families and some of their principal representatives. Science establishes two families, the *monkeys of the Old World and the monkeys of the New World*, and divides the latter into two sub-families, viz., the *claw* or *squirrel apes* and the *howling monkeys*, or scientifically the *Ouistitis* and the *Alouattes*. The home of the ouistitis extends from Mexico to Brazil. The squirrel apes are not yet perfect monkeys, though having the same number of identically shaped teeth as the monkeys of the Old World. Their limbs end in true paws, bearing narrow, compressed, and sharp pointed nails on the four fingers; the thumbs alone are provided with flat large nails like human nails. They are the representatives of the transition from the unguiculated quadrupeds to the quadrumana, and rank, physically and intellectually, far below the genuine monkey with heraldic quarters. The easy, bold, and graceful movements of the latter in climbing, jumping, walking, and resting are above their reach, and in the line of bodily abilities they hardly attain to their model, the squirrel. No one ever saw them walking in erect posture, and they always step on the full flat sole, contrary to the real monkeys, whose feet rest on the outer edge only. The cry of the squirrel-ape sounds like the whistle of mice or the pip of young birds, and its wit does not, by any means, reach the level of the genuine ape. A notorious coward, it shows all the coward's distinctive attributes—a plaintive voice, inability to submit to unavoidable facts and events, and the endeavor to swagger even in the moment of flight.

The first rank in the family of the apes of the New World belongs incontestably to the howling monkey. Its body is slender, its limbs are proportionately developed, its hands end in five fingers, and each finger shows flat, slightly convex nails. The fur is coarse, and the hair under the chin forms a kind of long, protruding beard. A distinctive feature is to be found in a kind of bony, sixfold drum or barrel formed by an inflation of the hyoid bone, which communicates with the larynx, and gives to the voice an enormous volume and frightful sound. Hence the name of howling monkeys. The long tail is naked, callous, and of great muscular strength at its extremity, and forms a convenient prehensile organ, which might be called a kind of fifth hand or rather the principal hand of the animal. The alouattes are not poor climbers, but they never take bold jumps, and always keep their hold by the tail till their hands have grasped the next limb, and this makes them slaves to the trees. They seldom venture upon the ground or rocks. The howling monkeys herd in troops, and follow slowly and awkwardly in the steps of their leader, whose slightest movements are imitated by every individual. There is no character in their voice nor in their general behavior: they act like automata, and yell and howl like maniacs. In the morning, when all the rest of nature is rejoicing in the new-born daylight, the troop of howling monkeys will descend gravely from the leafy tree where they have passed the night, closely gather in a huddled crowd, and having secured some breakfast, will proceed to indulge in a kind of social entertainment which is as exempt from frivolity and impropriety as it well can be, but which well reflects the character of the participants. The company make choice of some leafless tree, which they climb with great dignity. Each member takes his place as he pleases, but one large bough is reserved for the exclusive use of the leader, who paces it to and fro, solemnly raising his tail, and begins to utter low sounds, similar to the grunt of a young hog. The prelude grows insensibly louder, the time is quickened, after a few moments the pauses are omitted, and the wretched tune, sinister at first, becomes an uninterrupted, dreadful yelling. Now the crew are thrown into raptures, and all join in one deafening cry, and howl in concert. The powerful roar of the jaguar, the terrific growling of the panther, the wild shouting of a crowd of beastly, drunken rustics, lamentations, groans, seem to be combined in this chorus. And, curiously, the artists have no idea of expressing any special feeling. Such entertainments sometimes last several hours. Those long-tailed howlers are tiresome creatures, and I must confess that, in the matter of apes, the Old World takes the lead. Here also we find two sub-families—the *Cynopithecini* (dog-apes) and the *Anthroponorpha* (man-shaped apes). The former have perfectly developed teeth, like the quadrupeds, and a tail; the *Anthropomorpha*, on the contrary, have no tail, and their set of teeth resembles that of men, with the exception of the canine teeth, which are stronger and intermediate between those of beast and man.

The *Cynopithecini* present almost all the features in character which distinguish monkeys in general. The leadership is intrusted to the strongest male; he assigns to each member of the troop his duties, and watches for the general welfare. Their well-shaped hands give to these monkeys advantages which other animals do not enjoy, but still it is a question whether the dog could not in justice be placed on the same level with them as regards intelligence and sagacity. Apes and dogs show discernment, and exercise restraint on their manner of living; both are aware that every disorderly act on their side is followed by punishment, but the apes believe themselves far above the dogs. Excessively susceptible to reproaches, they want to be praised and fondled, while they themselves tease and insult other animals at every opportunity. They are docile, they eat with knife and fork, drink from the glass, dress, ride on horseback, submit to military drilling, wait on their masters, but only when, where, and as long as they are pleased, and never with the same care and conscientiousness that characterize a well-trained dog. There is no troop in the world so hard to manage as a troop of these monkeys, which peculiarity brings them near the hopeful youth of modern age. Another proof of their superior intellect may be found in the fact that they avail themselves of the means afforded by others to make their life as comfortable as possible.

I had often seen and closely observed individual baboons in captivity, but had never had a chance to meet those interesting animals living the life of liberty in organized troops. That pleasure was in store for me one morning, in the year 1862. I was traveling in Bogosland at the time. On the morning in question I found myself separated for a while from my companions, and had just sat down to take a short rest when I heard a kind of strange barking, coming from a steep cluster of rocks in the vicinity. Some minutes before, my attention had been aroused by a number of curiously shaped forms on the summit of the rocks, but I came to the conclusion that they were large blocks of stone. The barking disabused me, inasmuch as the forms, true and genuine baboons, were now starting up. Considering the shouting of the animals as a personal provocation, I hurried up the hill and fired a shot at the troop, which at once took to their heels and were soon out of sight. About half an hour later, after I had joined my friends, we saw the same troop in file on a narrow bridge running at a considerable height along a rocky wall. Another gunshot made them disappear once more, but a short distance farther, where the valley turned at a sharp angle, we met them just at the moment when they were crossing to reach the opposite hills. Our hounds, though trained to hunt hyenas, hesitated in bewilderment, but soon gave tongue, and made an impetuous rush at the monkeys. At once the old males rallied and faced the dogs, forming a wide semicircle, roaring, grinning, and furiously beating the ground with their hands. Their threatening attitude and spiteful glances frightened the hounds, which recoiled in amazement. The monkeys took advantage of this momentary failure of our animals, and retreated in haste. When the latter were rallied and started for a fresh attack, there were only a few more in the valley, and the last of the stragglers was a pug of about six months, which retreated in agonizing terror to the top of a large block of stone, where the hounds set it. "That pug will be ours," I shouted, but was thoroughly mistaken. One of the senior males, a strong, powerful individual, started from the other side of the valley, advanced quietly toward the block, pride and mischief shining in his eyes, marched straight to the hounds, which trembled under his vicious glances and threatening gesticulations, climbed the stone, fondled the young one, put it on his back and calmly returned, while we were standing there all startled. Similar acts of self-exposure of a male are only found among monkeys, while among all the other animals, even the lions, it is always the female which risks life to save her cub.

Some time afterward I crossed the same valley in company with Duke Ernst, of Coburg-Gotha, and near the same place we meet the troop moving halfway up on the rocky sloop of the hill. On the Duke's motion, we resolved to offer them fight. Seven men, armed with patent rifles, opened the attack. At the first volley the females took to flight with the young ones, while the males not only did not flee, but advanced, and in less than no time a formidable hail of stones whistled around our heads. Some of the stones thrown were as large as a man's head. It was full time for us to withdraw, and so we did. The monkeys remained the masters of the battle-field.

On my second voyage to Eastern Soudan we stopped in Khartoum during the rainy season. I suffered much, even more than I am suffering here in New York, from fever and chills. In the long, tedious hours of leisure we made a collection of monkeys, and those animals cheered me up many a time in my physical and mental troubles. We played with them, and at the same time undertook their training, and that in a fashionable manner. So we gave them riding-lessons. An old, fat, lazy donkey had the honor to serve as horse, and although the apes showed disgust and fear at first, one single lesson was sufficient to initiate them into the secrets of the noble sport, and in a few days they were in their way masters in the art. They would mount the donkey three, four, and five at a time, the first one embracing fondly the neck of the trotter with the forehands and cramping his hind-hands convulsively in the pelt of the animal's abdomen: the next one taking hold of his comrade, and securing his equilibrium in the same way by means of the hind-hands; and so on in a file. A funnier sight than this, four or five grinning apes closely nestled to the donkey's back, can hardly be imagined. The gray-haired trotter sometimes had to suffer from the mischievous riders, and did not conceal his feelings, to the great amusement of his tormentors. Besides playing, the monkeys were instructed in many little arts and tricks, and on that occasion I learned to appreciate them as smart and most sagacious creatures.

But passion makes them blind—unlike men, as it is said by the monkey-haters—as if men always kept quiet, composed, even-minded, and sober! As well as the apes in general, our baboons were passionately fond of strong liquors, and had a peculiar propensity for merisa, a kind of beer made of the grains of durrah by the inhabitants of the Soudan. Brandy was not to their taste, but, unfortunately, they made an exception one day. After having swallowed copious quantities of merisa, each one of the troop was offered a big glass of date-brandy, which he drank. As a consequence they became completely intoxicated, insolent, passionate, bestial, and grinned and gamboled in a fearful manner; in one word, they offered the hideous caricature of drunken men. The next day thirteen of the drunkards were suffering from the consequences of the spree, and looked sick unto death. All food gave them nausea; they turned away with disgust from merisa and even from wine, a favorite beverage in ordinary time; the only things they accepted were lemons, of which each one ate an average of twenty pieces. In this wretched state they comported themselves like men, and would, doubtless, have enjoyed a sour herring if it had been possible to secure this antidote in the country of the Mahdi. In the evening they felt better, and were all right the next morning. I hoped this hard lesson would teach my pupils the advantages of abstinence, but, alas! I was mistaken once more in my life. They drank and reveled all the same, and from that day drank brandy with predilection. More than that, they claimed their rum every day as a privilege.

I took one of these baboons—it was a female—along to my home in Germany, because she had always proved to be of extraordinary sagacity, and actually exhibited a far greater intelligence than the average of the countrywomen of Thuringia, where I was living. Apes in general like other creatures, provided they submit to their caressing and fondling. My baboon at first concentrated her tenderness upon the children of the village, but, to her great sorrow, found no reciprocity. Then she turned to cats and dogs, and teased and tormented them in every way. A bright pussy, which the most of the time she carried in her arms, was tired one day of her company, and attempted to escape. The ape strongly objected, and the kitten, in its struggles, scratched her in the shoulder. Gravely the baboon seized one of the paws of her pet, examined it carefully, and finding, probably, the sharp claws a dangerous superfluity in so small a being, bit them all off, one by one. We sometimes tried a practical joke on her by putting a little powder near the place where she was secured during part of the day, and flashing it by means of burning spunk. When the powder flashed, she screamed and jumped back as far as her chain permitted it. But she had very early found out the connection of things; the next time we threw the burning spunk near the powder, she rushed forward, extinguished it, and quietly ate the explosive, which she probably relished on account of its saltpetrous taste.

The aptitude of the *Cynopithecini* to distinguish between cause and effect is really remarkable. They are aware when they have done wrong, and expect punishment. An old *crowned guenon*, also called *Chinese bonnet*, living in captivity, once assaulted its attendant, lacerated his arm, and cut an artery. The animal being an old offender, the master ordered it to be shot. When the man charged with carrying out the order approached the cage of the ape, the latter, apprehending his fate, retreated to the adjoining shanty serving as bedroom, which communicated with the cage by a door. Neither flatteries nor tempting tidbits could move him to come out from there. The man then had dinner brought and placed in the front cage as usual, and walked off. As soon as he was out of sight, the monkey cautiously crawled out, took part of the food, and jumped back to his hiding-place. He went a second time, but found his retreat cut off, the door between the cage and the shanty having been shut. Seeing at the same moment the attendant armed with the dreadful gun reappear, the monkey understood at once that he was lost, jumped furiously at the closed door, tried to escape through every corner, and, finding that flight was impossible, lay down trembling, and awaited the deadly bullet.

The ape holds himself far above the other animals,

and endeavors to make them understand it. My baboon showed her superior standing by tormenting every other animal in the house without any reason or the slightest provocation. I had an old dog whose temper had been spoiled by age, and which lived in open war with every creature in the house. My baboon picked it out as an object for her tricks. When the dog was taking its *siesta*, the ape would crawl cautiously near, seize the animal by the tail, and, jumping back, give it an awful jerk. The dog, aroused from slumber, flew into a violent passion, and went howling and barking for the ape, who quietly watched him, and aggravated his excitement by patting the floor with her hands. As soon as the dog was near enough to reach her, she made a jump upon his back, and again squeezed his tail. These successive insults made the dog nearly frantic; he foamed and howled, but the more excited he grew, the worse the monkey tormented him. Finally, the old hypochondriac, seeing the uselessness of trying to chastise the foe of his rest, marched off with his tail between his legs whenever the monkey showed her face.

The sagacity and docility of the *Cynopithecini*, wonderful as they are, cannot be compared with the intelligence of the *Anthropomorpha*, especially the chimpanzee, the gorilla, the orang-outang, and others. I have closely observed several individuals of the family, allowed them to play with my children, and cared for their training and education, and have drawn astonishing results from my studies. These monkeys are creatures which one treats involuntarily like men, or at least like children. The orang-outangs are melancholic, and not very sympathetic with men; the variety of the pongos, to which the chimpanzee belongs, is jovial, and by far the most intelligent. Their voice is pure and plain, and while it cannot be denied that the voice of the gibbons sounds more melodious, and constitutes a veritable song, that of the chimpanzee is a formal language. All the sounds are fully accentuated, and the observer soon understands the meaning of the different modulations, while children, playing with the animal, catch at once the sense of its utterances.

It is really impossible to treat the chimpanzee like an animal; his character and general behavior show so much of humanity that men are induced to commune with him in the same way as with their equals. In captivity he is perfectly conscious of his position, and subordinates himself willingly to the superior mental gifts and capacities of mankind, but holds himself better and higher than other animals, especially than other monkeys. Paying in every instance high regard to men, he likes children if they do not tease and molest him. Sportive and humorous, he indulges in joking with men and animals. He is not only inquisitive, but eager to acquire knowledge, examines carefully things strange to him, and falls into ecstasy when he has found out their purpose and learned to use them in the right way. While able to understand men and things, he is, nevertheless, modest and kindly, seldom willful, and never stubborn, although he claims what is in right due to him. Of variable temper, he is now good-humored and jolly, now sad and morose, and gives vent to his feelings as men do, but sometimes in a more passionate way.

I was once the owner of a highly educated chimpanzee. He knew all the friends of the house, all our acquaintances, and distinguished them readily from strangers. Every one treating him kindly he looked upon as a personal friend. He never felt more comfortable than when he was admitted to the family circle and allowed to move freely around, and open and shut doors, while his joy was boundless when he was assigned a place at the common table, and the guests admired his natural wit and practical jokes. He expressed his satisfaction and thanks to them by drumming furiously on the table. In his numerous moments of leisure his favorite occupation consisted in investigating carefully every object in his reach; he lowered the door of the stove for the purpose of watching the fire, opened drawers, rummaged boxes and trunks and played with their contents, provided the latter did not look suspicious to him. How easily suspicion was aroused in his mind might be illustrated by the fact that, as long as he lived, he shrank with terror from every common rubber-ball. Obedience to my orders and attachment to my person, and to everybody caring for him, were among his cardinal virtues, and he bored me with his persistent wishes to accompany me. He knew perfectly his time for retiring, and was happy when some one of us carried him to the bedroom like a baby. As soon as the light was put out he would jump into the bed and cover himself, because he was afraid of the darkness. His favorite meal was supper with tea, which he was very fond of, provided it was largely sweetened and mixed with rum. He sipped it from the cup, and ate the dipped bread-slices with a spoon, having been taught not to use the fingers in eating; he poured his wine from the bottle and drank it from the glass. A man could hardly behave himself more gentlemanlike at table than did that monkey.

He was especially engaging in his association with my children, always gentle, obliging, and tender, and they liked him as a good fellow and pretty playmate. When he was first introduced to my little girl, who was then six months old, he seemed perplexed, and observed her with astonishment, as if speculating whether that little bit of a creature was really a human being. At last his mind was made up; he touched her cheek with one finger, and then offered her his hand in friendship. My chimpanzee conversed very little with other animals; like the apes in general, he was afraid of the big ones and despised the smaller ones. He was always around us, and we, on our side, did not make any difference between him and a man.

The animal fell ill of mumps, followed by pneumonia. I had seen many sick chimpanzees, but never one of them behaved as he did. I engaged two competent physicians to take charge of him. He knew them from the first day, allowed them to feel his pulse, showed his tongue, and directed the hand of the attendant doctor to the painful swelling, which had to be cut open afterward, there being danger of suffocation. The doctors would not use chloroform, out of regard to the affection of the lungs, but, fearing the chimpanzee would not keep quiet during the operation, engaged four strong men to hold him. The sick animal did not submit to that rough treatment, but excitedly pushed the men aside, and then, without any compulsion whatever, but in compliance with the fondling words of his nurse, in whose lap he was sitting, offered his throat. The operation was performed, the ape never flinching or complaining. He felt afterward much relieved, and expressed his gratitude by pressing fervently the hands of the physicians and kissing his nurse. But his life was not spared; he died from pneumonia. Meekly and patiently he bore his long agony, and died more like a man than an animal. The doctor told me that never in his life, at any death-bed, had he felt an emotion similar to that which seized him at the humble couch of the poor monkey. In Berlin, many beautiful eyes shed tears when the news of the sad end of my widely known and generally petted chimpanzee was spread.

Was the ancestor of the human race a monkey? That is the vexed question which still raises so much dust.

There is no doubt that man is not more and not less than the chief creature in the animal kingdom, and that the monkeys are his immediate neighbors; but I cannot see why this fact should logically involve the assumption that our great-great-uncles were gamboling in paradise in the shape of apes. The doctrine of gradual evolution may seem trustworthy in the highest degree and beautiful from the scientific standpoint, but it is based upon a simple hypothesis, and a hypothesis is not a proof; and here I wish not to be misunderstood. Even if the physical and intellectual development and perfection of humanity throughout the succession of thousands of centuries is a fact, there is no authority for the inference that, *eo ipso*, a monkey-nest was the cradle of mankind.

Darwin's treatise on the variation of species gave rise to the ardent controversy of our days. Darwin used the wrong word. It is not "species" he ought to have said, but "varieties"; for species never interbreed with each other. Man and monkey, though belonging to the same group, represent two distinct species. There is, consequently, a simple and irrefragable natural law refuting peremptorily the thesis of the enthusiastic propugnators of the pedigree rooting somewhere amid a grinning tribe gamboling in the wild forests of Asia or Africa. The criterion that the human race has large, round hands and blunt canine teeth would be sufficient of itself to establish the truth that no monkey-blood is pulsating in our veins; but there are more distinctive features. Men have strong, well-shaped legs, walk constantly in an erect posture, and enjoy the faculty of speech.

The monkeys rank near humanity in the general organization of the world; they show in many instances much likeness with mankind, physically as well as intellectually. But a further concession would be a denial of positive natural laws. Nay! old Adam was not a monkey, not a baboon, not even a chimpanzee! —*Popular Science Monthly.*

CAUSES OF SEX.

J. SCHLECHTER (*Rev. f. Thierheilkunde*, Nos. 7 and 8, 1884) has investigated the reproduction of horses; dealing with 2,064 births, and examining first of all the influence of the absolute and relative ages of father and mother. He found that the proportion of female to male births was as 100 to 91·3; where the sire and dam were of the same age, and between 4 and 12 years of age, more females were born; but when they were between 12 and 16, a considerably larger number of males. When the sire was older than the dam, a larger number of males was born where the difference was slight, and a larger number of females when the difference was more extensive. When the dam was the older, a larger number of fillies was produced.

The second problem is that of the influence of the first and later copulations on the resulting sex; fillies were to young horses as 100 to 90·2, where the dams were covered for the first time; and the proportion was exactly the same where the dams had been mothers. The time of the year has this importance, that the production of females is to that of males as 100 to 90·2 in the cold months of the year, and as 100 to 89·5 in the warmer months. More males seem to be produced when the virile activity is at its highest point; males are on the average eight-tenths of a day longer during the gestation period. The first-born are rather more frequently males.

H. Berner (in a work published at Christiana, 1883) demonstrates that the hypothesis of Hofacker and Sadler, which explains the excess of boys born in Europe by the fact that the husband is ordinarily older than the wife, is untenable. The author's results are based upon the Norwegian statistics of population for 1871–1875. There were 213,224 births, 109,431 of which were boys, or a proportion of 105·43 boys to 100 girls. Where the parents were of the same age, the proportion of boys to girls as 106·23 to 100; when the father was one to ten years older, as 104·61 to 100; where he was more than ten years older, as 103·54 to 100; where the mother was one to ten years older than the father, as 107·45 to 100; where she was more than ten years older, as 104.10 to 100. On the whole, then, the results are just contrary to what we should expect from Hofacker and Sadler's hypothesis. Berner approves of the doctrine of Richarz, that, if the mother is especially fertile, a boy, that is, the higher and more complete developmental form of the genus *Homo*, is produced; while when the mother is weakly, or less adapted for procreation, the result is a girl. In the former case the mother's influence is predominant, in the latter she is more indifferent than the male; or, in other words (and, indeed, in the terms of a very widely distributed belief), the peculiarities of the mother pass as a rule to the son, and those of the father to the daughter. The predominant importance of the mother is to be explained by the facts that unfertilized eggs may become developed into viable organisms (parthegenesis of insects), that ovarian dermoid cysts are due to a real though an incomplete development of the ovum, and that the spermatozoon lives for a shorter period than an ovum. A reviewer (*Biolog. Centralbl.*, iv., pp. 461–465) suggests that the cause of a larger number of males being produced after a war is not, as the author thinks, due to the increased social advantages dependent upon less rivalry and to an increased activity, but to the enfeeblement of the males and to the quiet life led by the females puring the period of war. Polygamous marriages, one result of which is that females do not have children more than once in two or three years, have for another a great preponderance of male births, and so prove the influence of the mother on the birth of sons. Prosperous years are also favorable for the production of males. The hypothesis of Richarz is supported by the facts that from unfertilized eggs among insects only males arise; among hybrids (when the ovum is under its normal physiological conditions, but the semen under more or less abnormal) males are most common, and more resemble the mother. The experiment of Fiquet, a farmer in Texas, who was able to determine the sex of the progeny by different modes of feeding the mother, is referred to. On the other hand, madness seems most often to pass from father to son, and from mother to daughter, the proportion being 53·3 to 46·6 per cent.—*Journ. Royal Micros. Society.*

REGULATION OF SEX PROPORTION IN ANIMALS AND PLANTS.

IN an elaborate essay in the *Jenaische Zeitschrift für Naturwissenschaft*, K. Dusing starts from the fact that in animals, as in man, male and female individuals always and everywhere stand to one another in quite definite numerical relations; in *Homo sapiens* the proportion is about 106 boys to 100 girls; the former, however, are more frequently stillborn, and a larger number die in childhood. The consequence of this is that, at the period of greatest reproductive activity, the number of each sex is about equal. Nearly similar results obtain with domesticated animals. Nor is the constancy confined to animals, for Heyer has shown that a definite relation of the sexes obtains in the dioecious plant *Mercurialis annua*.

It is, however, well known that with small numbers very different results from those just enunciated are obtained; in other words, there is often a divergence from the norm. How is this corrected? Dusing answers that an excess of one sex brings about a larger number of births of the other. The author then discusses the statistics of births, and especially of those after wars.

If the author's doctrine that nutriment has influence upon the sex be correct, it is clear that animals with similar nutrition must be generally of the same sex; and this is true, we know, of twins and double abortions.

The author next investigates the effects of dissimilar nutritions, and begins with a study of human statistics. With bad nourishment a boy, with good a girl, is developed; in the country there are more boys born than in towns, for the townspeople are, on the whole, better nourished. Parents in good condition have fewer boys than the poor. The age of the mother is also of importance; young females feed better than old, and have more girls. Where bodily exercise is considerable, as among the inhabitants of young countries, such as North America and Australia, there is a preponderance of male births.

These principles may be applied to thelytoky, which is caused and conditioned by an oversupply of females, to arrenotoky, where one female is fertilized, and to asexual generation, whether by fission, gemmation, or pædogenesis. The same rules will apply to plants.

It is a great advantage to be hermaphrodite as long as possible, as the tendency of one sex can be altered at a comparatively late period in embryonic life; as we know, the embryos of nearly all animals are at first hermaphrodite.

W. K. Brooks (in Johns Hopkins University Circulars) quotes and approves Dr. Dusing's papers on the laws which regulate sex, and his statements that a favorable environment causes an increase in the number of births of female children, while an unfavorable environment causes an increase in the number of male births.

Mr. Brooks believes that this is only part of a still wider generalization, and quotes facts to show that the male cell causes variation, while the ovum transmits the hereditary characteristics of the species. The union of two sexual elements has been evolved for the purpose of securing variability, and the male element has gradually acquired, by division of labor, the peculiar function of exciting variability to meet changes in the conditions of life. So long as the latter remain favorable, there is no need of variation; but whenever any unfavorable change takes place, variation becomes necessary to restore the harmony between the organism and its environment. If this view be true, we have in Dusing's results an exemplification of one of the most far-reaching of all the adjustments in nature; an adaptation by means of which each organism remains unchanged so long as no change is needed, while it begins to vary whenever variation and race modification are called for.—*Journ. Royal Micros. Society.*

CAMPHOR BAROMETER, OR "STORM GLASS."

IT was discovered by our ancestors that the height of the undissolved camphor in a camphor bottle was different in different states of the weather; and it became quite customary to keep a camphor bottle in sight, in order to anticipate the change in the weather, it being thought that an increase in the height of the camphor indicated approaching rain or wind. The inventive genius of our age could not long allow the instrument to remain in this crude form.* The camphor† and alcohol were put into long glass tubes hermetically sealed at the top, and adjusted in a frame with a thermometer attached. The side of the frame next the tube was divided into three divisions. On the bottom one was marked the word "Fair," on the middle one "Change," and on the top one "Storm." A note accompanying the instrument stated that the weather was indicated by the word in the division with which the top of the chemical substance corresponded. It also stated that the direction of the wind was shown by the substance being a little higher on the opposite side from which the wind came. These were manufactured and sold all over our country under the name of "Storm Glasses," or "Chemical Barometers." One firm, I suppose in order to increase the sales, adopted the name of "Signal Service Barometer;" and I have met a number of people in possession of these instruments who really thought they had one of the genuine barometers which the Signal Service used in its predictions.

The fact that the manufacturers have hermetically sealed the top of the tubes fortunately assists in an investigation of the cause of the instrument's action, for it is evident at once that the contents of an impermeable, air-tight vessel of glass can neither be affected by

* The first improvement was, I believe, made by Admiral FitzRoy.

† Other ingredients besides the camphor, I believe, are now included. I find it stated that two parts camphor, one part nitrate of potash, and one part salammoniac are put into the alcohol, and a little water added.

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variations in the atmospheric pressure nor moisture. That light is not the cause of its action can be easily shown, for the chemical substance varies in height in the dark just as it does in the light. Neither can its changes be due to the action of the electricity of the air, for the changes of the tube take place the same in a protected shelter as they do in the open air, and the electric potential inside of a shelter is always zero.* We turn to changes of temperature for the cause of its variations, and find a most satisfactory explanation of its action. If it is winter, one can easily convince himself of this by taking the instrument into a warm room. If now the instrument be hung out of doors, the precipitate will in a little while increase greatly in quantity, and if the difference of temperature is considerable, the alcohol in the tube will be filled from top to bottom. I have a tube on which I have divided the length from the top of the alcohol down to the bottom into ten parts, and these again into ten parts, so that I can read the height of the precipitate at any time in hundredths of the greatest height to which it is possible for it to extend. March 24, I found the instrument hanging in my room read 21 on the scale, temperature inside of room 73°, outside 27°. I placed the instrument outside, and in two minutes little stars began to form at the side and to move down toward the bottom and up to the top again in the center of the tube. These continued to increase in size, and in five minutes the alcohol was about one-quarter full of them. As these increased and the circulation of the liquid became slower, they began to accumulate at the bottom and somewhat at the top, until in twenty minutes the alcohol was full from top to bottom. I brought it inside the house, and in a few minutes the precipitate began to take on a more attenuated appearance and to slowly decrease in height. In forty minutes it read 21 again. Readings of the height of the precipitate taken every ten minutes were as follows: 4:55 P. M., 100; 5:05 P. M., 93; 5:15 P. M., 80; 5:25 P. M., 50; 5:35 P. M., 21. Another instrument with a scale arranged in exactly the same manner had been hanging outside for a month or two, and read 50 during the whole experiment. The instrument in my room was next put into warm water, and I found that at a temperature of about 100° every particle of the precipitate would disappear.†

If allowed to remain in the water while it cooled, little stars or flakes would begin to appear in the alcohol, and when it had fallen to a temperature of 70° or 75°, the alcohol would be entirely filled with the precipitate. If, then, the indications of the instrument are to be relied on, it is easy to get up a storm on short notice.

Suppose, when an instrument has been carried out of a warm room and the precipitate fills the alcohol from top to bottom, that it is left outside, as was done on the first of January, with the instrument hanging outside referred to above. In such a case, after the instrument has been out some time, the column of precipitate will begin to shorten, even though the temperature remains the same; and it will be noticed that the bottom presents a more compact appearance. After about a week or ten days, the precipitate will have entirely lost its feathery appearance, except, perhaps, a little at the top, and will present a compact granulated mass filling about half the tube, if it is winter, and about one-quarter, if it is summer. If while the column of precipitate was shortening there was any considerable change in temperature, there might be some minor oscillations in the length of the column, but the whole tendency would be downward. When this state is attained, the precipitate dissolves very slowly in the alcohol, and the instrument is capable of going through considerable changes in temperature without much change in the height of the precipitate. Thus, suppose in the morning the temperature was 40°, and by noon had risen to 50°, the height of the column may show no perceptible decrease, because the dense crystals dissolve slowly, and the alcohol lacks considerable of containing as much as it could dissolve at the latter temperature; but when toward night the temperature again falls to about 40°, the liquid is nearly saturated; and, if by the next morning the temperature has fallen to say 32°, the liquid will be filled to a considerable height with light, feathery crystals which readily dissolve on a rise of temperature, or if the temperature remains stationary, settle to the bottom changed into the more compact granular crystals. To illustrate from observation—on January 13, the temperature in the room for about a week had been ranging from about 60° to 70°, and the height of the precipitate in the instrument had been almost steady at 23 on the scale, when the temperature in the room on the evening of the 13th fell to 52°, and light flakes of precipitate began to form. I knew the liquid was now supersaturated, and any further decrease in temperature would cause a decided precipitation. On the morning of the 14th, the temperature had fallen to 43°, and the height of the column of precipitate was 32 on the scale. I observed the instrument inside the house and the one outside, three times a day during January and February, and it was always found that the height of the two columns varied in opposite directions whenever the temperature changes inside and outside were in opposite directions.

I observed the instrument three times a day during the whole summer and autumn of 1881, and there was never an increase in the height of the precipitate without a corresponding fall of temperature, or a decrease without a corresponding rise of temperature. It will thus be seen that the instrument is not a "storm glass" or a "chemical barometer," but a chemical thermometer, and a very poor thermometer at that.

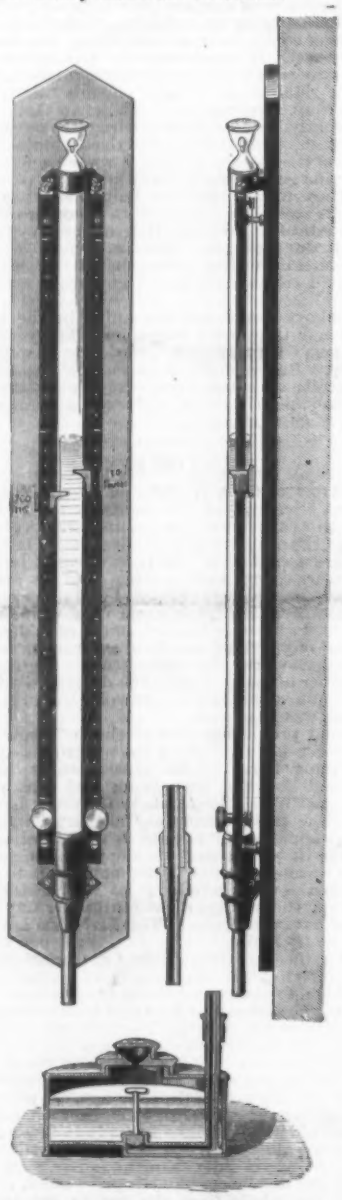
Do its indications bear any relation to weather changes? Yes; because temperature changes are closely related to other weather changes. In the summer, under an extended but moderately high pressure area, or anti-cyclone, there usually exists beautiful, fair, warm, settled weather, and the top of the precipitate will be even with the division marked "Fair." When showers come on, the air turns cool, and the precipitate rises to the division marked "Change." Whenever an area of decided low pressure passes over the country, the air is warm in front of it; and as the center passes over, there is usually a sudden fall of temperature. This causes the precipitate to rise up to the division marked "Storm," and the wind in such cyclonic systems is always high, especially in their rear. In the winter the top of the precipitate is nearly always up in the division marked "Change," and as the weather is eternally changing, I suppose it may be considered about right. On the contrary, a decided anti-cyclone may in summer bring cool weather; and the precipitate will rise up into the division marked "Storm," accompanied by the clearest skies and delightful breezes. It is also common for rains to pass over without any material changes in temperature. In such cases the height of the precipitate will remain unchanged. The indications of the instrument are then sometimes right, sometimes wrong, like the negro's dumb watch, which was always right twice a day, but, as it gave no indications of the time when it was right, it was not worth much as a practical instrument.—*H. Helm Clayton, Amer. Met. Jour.*

* I exposed an instrument for fifteen minutes to an electrical machine charged to high potential, and no change whatever took place in the height of the column in the tube.

† In order to make it dissolve rapidly, it is well to shake it up before putting it in water.

THE GLYCERINE BAROMETER.

THE marked influence of the variations in the pressure of the atmosphere upon the disengagement of carbureted gases in coal mines has led the English engineers to devise a new barometer that will not only indicate the most minute variation of atmospheric pressure, but will indicate it so plainly that miners and others not experienced in making barometric observations can readily detect the variations.



THE GLYCERINE BAROMETER AT THE KEW OBSERVATORY.

Among the instruments of this class one of the most interesting is the large water barometer constructed for the Royal Society by Prof. Daniell, in 1830, which, however, was not a success, as the effects of the pressure were annulled by the effect of the temperature upon the vapor found in the Torricellian vacuum.

Mr. B. Jordan, a member of the office of the English mining archives, has spent several years in studying the different liquids that might possibly be applicable in constructing an accurate and highly sensitive barometer, and finally found that glycerine produced the best results. A glycerine barometer constructed by Mr. Jordan, 1870, is still in use. The glycerine, which is very pure, is manufactured by Price & Co., and has a specific gravity of 1·26, and on account of its high point of ebullition the vapors have no perceptible tension at the ordinary temperature, and it will only congeal at a very low temperature. The height of a column of glycerine is 26 feet 9 inches, and a variation of 1-16th of an inch of mercury corresponds to a variation of about 1 inch in the column of glycerine. As glycerine is very apt to absorb the moisture of the air, it is covered with a thin layer of prepared thickened petroleum in the cistern of the barometer. Mr. Jordan has constructed barometers for the South Kensington and Jermyn Street Museums; both have given perfect satisfaction, and to show the scientific value of the instrument the Royal Society has built one at the Kew Observatory.

This instrument is shown in the annexed engraving, and consists of a cylindrical cistern of tinned copper, about six inches high and ten inches in diameter, provided with a screw cover or cap, having a small opening leading into a recess containing cotton to act as filter and keep out the dust. The large barometric tube is made of ordinary gas pipe, about three-quarters of an inch in diameter, and is rigidly attached to the cylindrical cistern or cup. The upper end of this tube fits into a piece of bronze, into which a glass tube, three-quarters of an inch in diameter and about four feet high, is securely cemented. This tube terminates in a cup inclosing a rubber packing. Graduated scales provided with indicators are placed at each side of the glass tube, the one on the left side indicating the inches and tenths of inches, and the right-hand scale shows the equivalent measure of a corresponding column of mercury. The scales are attached to an oaken plank, which is fastened to the wall of one of the upper stories of the observatory, and the large tube passes down to a room situated twenty-six feet nine inches lower. The glycerine in the barometer is colored with aniline red. Before putting the glycerine in the tube it is boiled at a temperature of about 180° to expel the air and to make it purer. The air is exhausted from the barometer tube by means of an air pump. Regular observations are made with the instrument at the Kew Observatory under the surveillance of Mr. Whipple, who considers the apparatus to be a scientific instrument of the greatest precision.

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